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February 10, 1938

ANNUAL REVIEW

CIVIL ENGINEERING AND CONSTRUCTION DURING 1937

An Editorial Survey

Construction Activity and the 1938 Outlook

Special Reviews of Major Fields

S. C. HOLLISTER · GEORGE B. GASCOIGNE · ALBIN L. GEMENY
GLENNON GILBOY · THEODORE T. KNAPPEN · HENRY D. DEWELL
J. C. STEVENS · L. D. GAYTON

Speaking for the Contractor
EDWARD P. PALMER

Rainfall and Streamflow Record of the Year
JOHN C. HOYT

Status of Major Engineering Projects

A Chronology of Events

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Longer Life Less Load

Bridge Railings of BYERS WROUGHT IRON

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· ENGINEERING NEWS-RECORD ·

McGRAW-HILL PUBLISHING COMPANY, INC.
WILLARD CHEVALIER, *Vice-President*
Editorial and Executive Offices: 330 West 42nd Street, New York . Publication Office: 99-129 North Broadway, Albany, N. Y.

F. E. SCHMITT, *Editor* ALBERT E. PAXTON, *Manager*
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Vol. 120 *FEBRUARY 10, 1938* No. 6

THIS WEEK AND NEXT

THIS WEEK'S PAGES are given over to a review of civil engineering and construction during 1937. Except for the space required by current news and the construction reports its pages are devoted to significant statistics and to appraisals by the editorial staff and by special writers of significant trends or developments.

Heavy construction, ENR statistics show, did not attain the 10 per cent gain over 1936 that had been anticipated as late as midsummer but it did surpass that year by 5 per cent, which is something to boast of, since general business could do no better than break even with the previous year. Particularly encouraging is the fact that private construction gained, while public construction fell off.

New capital for construction gained 37 per cent over 1936, in itself a significant figure, but a more momentous fact is that funds obtained from private sources exceeded one billion dollars.

Construction costs as measured by the ENR Cost Index continued for six months the steady rise begun in the middle of 1936; in the second half of the year the rise flattened out—a change that may be expected to continue through 1938, with a chance of slight decline.

An editorial survey of the past year's developments and progress is supplemented and amplified by a group of eight special articles relating to fields in which there has been notable activity. The authors are leading engineers, recognized as authorities in their fields. The subjects include bridge engineering, water supply and treatment, sewage treatment, hydraulics, flood control, soil mechanics and research. Two other authoritative articles deal with the year's water record and with the problems of contractors.

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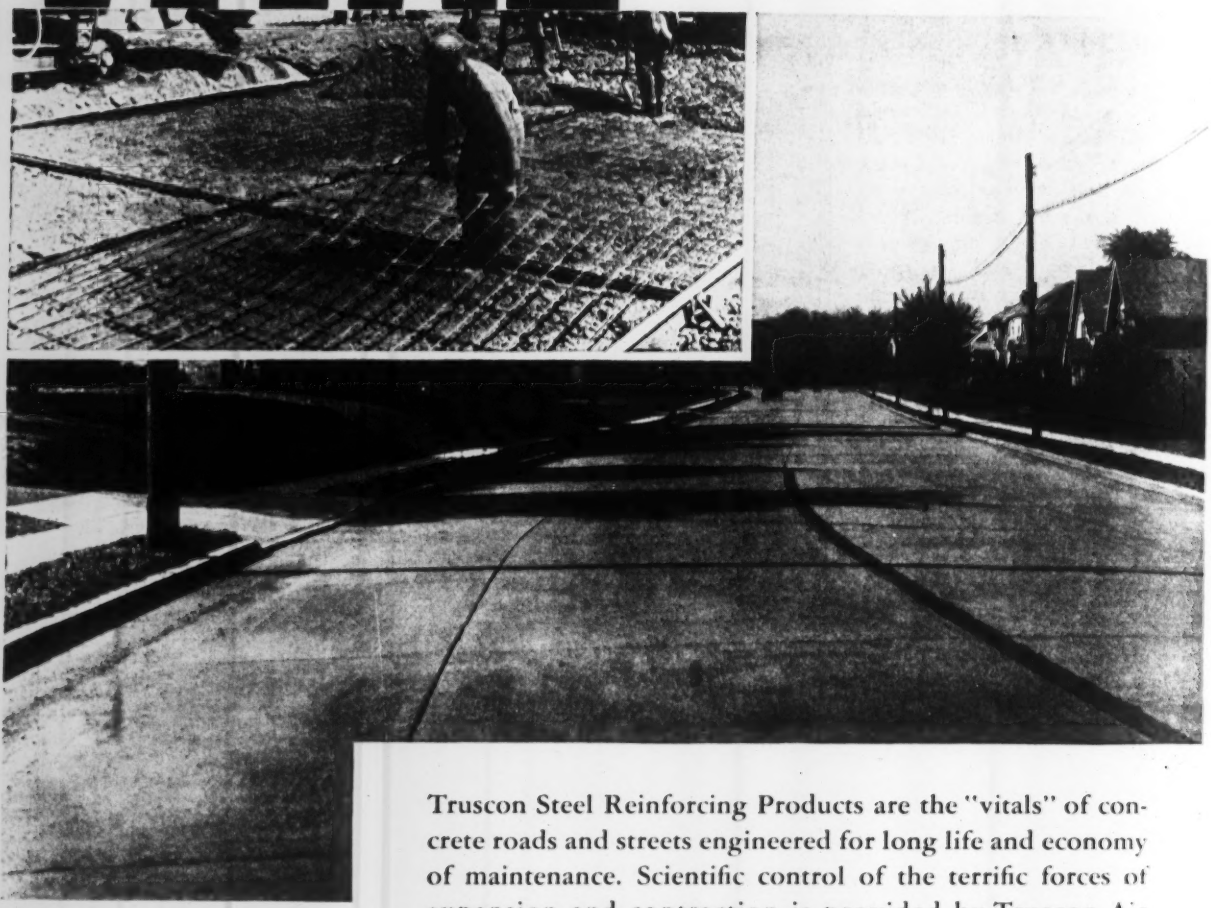
Number of copies of this issue printed: 33,388

VITAL

To the LIFE of Concrete Highways



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THE WEEK'S EVENTS

Connecticut Settles Road Jurisdiction

State Supreme Court rules highway department has jurisdiction over roads and bridges

Jurisdiction over the layout, construction and maintenance of Connecticut highways was ruled to lie with the state highway commission by a decision of the state Supreme Court of Errors Feb. 2. The state Public Works Department, to which the legislature gave control over "real assets" of the state was held not to have control over highways.

The 1937 session of the legislature passed a public works act setting up a public works department and giving it control over "real assets." The state attorney-general subsequently ruled that this expression gave the public works department jurisdiction over all highway construction and maintenance. Conferences were later held between the two departments regarding town-aid jobs, which are partly financed by the state from an annual appropriation of $3,600,000. As a result of these conferences, town-aid work was transferred back to the highway department. Then the U. S. Bureau of Public Roads notified the state that it would regard the highway commissioner as the state official authorized to handle federal road grants.

The case entered the courts when the Connecticut Rural Road Improvement Association sought to enjoin the Commissioner of Public Works from asking bids and awarding contracts for highway work. The state Superior Court held that jurisdiction lay in the highway department but refused the injunction on the ground that the association did not have an interest in the case, and the case was appealed to the Supreme Court.

In its decision, the court took account of the fact that the public works act as passed was a part of a general reorganization act on which final action has not been taken. An earlier section of the proposed act laid out the duties of the highway department. The court pointed out that the existence of this earlier section made it clear that the term "real assets" as used in the proposed reorganization act did not include highways. It held, therefore, that when the term was used in the public works act as passed, the legislature did not intend the term to include highways and bridges.

RAILS START ACROSS BRIDGE

FIRST RAIL SPIKE for the railway facilities on the bridge proper of the San Francisco-Oakland Bay Bridge was driven Feb. 1 by Charles E. Andrew, bridge engineer (stooping, at extreme right), assisted by James Graham (kneeling), superintendent for the Pacific Bridge Co., the track work contractors. Standing, left to right, are: L. R. Spencer, junior engineer; S. H. Phelan, foreman for contractors; and R. C. Cantrell, associate engineer.

• • •

Second Road Program In Mississippi

A $40,000,000 highway construction program to continue the work begun in last year's $42,500,000 program is provided for in a bill passed by both houses of the Mississippi legislature. Since the bill is an administration measure, gubernatorial signature is assured.

The measure provides that $60,000,000 of highway construction bonds be issued. Of this sum, $20,000,000 will be used to refund bonds issued as part of last year's program, and the remaining $40,000,000 will be used for new construction.

Bargaining Demanded On Federal Jobs

Congressmen investigate use of RFC funds to fight strike on San Jacinto Tunnel.

Senator Wagner of New York has introduced into Congress a bill which would require collective bargaining to be guaranteed in contracts entered into by any agency of the federal government or by any person or corporation receiving federal funds in the form of loans or grants. The bill would cover contracts for manufacturing, processing, construction, or furnishing of materials, supplies or equipment.

Cancellation of the contract is provided as a penalty for failure to comply with any order of the National Labor Relations Board or for engaging in unfair labor practices as defined in the Wagner Act.

Last summer's strike on the RFC-financed San Jacinto Tunnel, in which the CIO sought union recognition and reinstatement of men allegedly fired for union activities from the Metropolitan Water District of Southern California, came under investigation at the same time. Representative Scott and four other California Congressmen announced after a conference with RFC Director Henderson that the water district will be requested to report how much, if any, of its funds have been expended for tear gas and guards during the strike.

The California Congressmen are trying to ascertain the truth of a charge that $50,000 has been spent by the district in fighting the strike.

Strike still on

Commenting on Senator Wagner's bill, the Washington office of the CIO asserted that the San Jacinto situation exemplified the need for such legislation. John Brophy, CIO director, said that the water district's contention that no RFC money had been used in fighting the strike was "a mere bookkeeping legalism." He said that the striking workers were still maintaining their picket lines at the tunnel, although they are compelled to lease the land on which they picket.

Utility-TVA Truce Is Possible

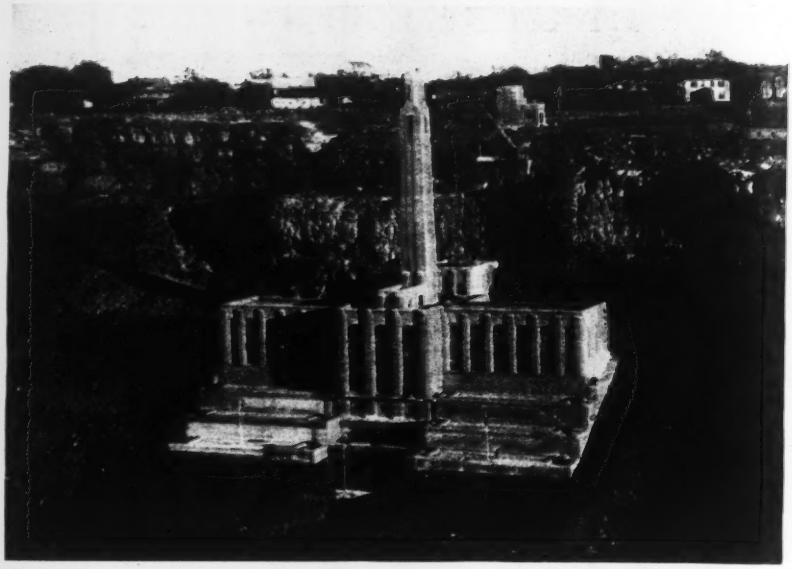
Washington Correspondence

Resumption of negotiations between private utility companies in the Southeast and the TVA is anticipated as the result of two recent court decisions upholding the right of the PWA to make loans and grants for municipal power construction and the general constitutionality of TVA's power activities. Both sides have, in an oblique manner, indicated their willingness to talk business—the Commonwealth and Southern by President Willkie's offer to sell its southeastern companies in toto; TVA by the appointment of Director Lilienthal as negotiator with the power company.

It would be rash, however, to predict an immediate peace pact. Mr. Willkie's offer is too simple to be practicable; it overlooks the fact that, although his four operating companies all compete so some extent with TVA, no one of them is entirely within the area to which TVA's operations are limited by law. An additional complication lies in the fact that TVA has neither the intention nor the desire to enter into the retail distribution of power. It has done so, and presumably will again, on a temporary basis, but only when definite arrangements for the subsequent transfer of the distribution function to local interests are assured. This brings the municipalities and, to a lesser extent, the co-operatives into the picture.

Knoxville plan

If and when a final compromise is reached, it will probably follow the principles of a solution already negotiated but not carried through in the Knoxville area. The city voted to go TVA, and tried to buy out the existing distribution system of the Tennessee Public Service Co., a subsidiary of Electric Bond & Share. The company objected that, with its big load gone, it could not continue to serve some 30 smaller communities nearby. So an agreement was reached by which the transfer was to include all company facilities in the entire area at a price of $6,080,000. TVA was to take the transmission facilities; the various municipalities their respective distribution systems. The plan was approved by the operating company and its holding company, by TVA, and by all the municipalities. It was about to go through when two minority stockholders and 13 local ice and coal companies took it to court. The temporary injunction they obtained held until after the deadline had passed, so the agreement fell through at that time.



A UNIQUE SEWAGE DISPOSAL PLANT

DEPARTING from convention in both site location and method of treatment employed, the Niagara Falls sewage treatment plant, on which test runs are now being made, can lay claim to being a unique disposal works. Clinging to the sheer sides of the Niagara river rock gorge, the plant can be reached only by an elevator, the head of which is visible to the right of the chimney. The intercepting sewers serving the plant are in a tunnel some 120 ft. below the top of the rock escarpment.

The treatment process is unusual in that fine screens covered with a 6-in. filter mat of anthracite coal will be used to effect partial purification of the sewage up to 50 m.g.d. The coal mat can be quickly swept off the screens when the plant is called upon to handle storm flows above 50 m.g.d.

Screenings will be dewatered in centrifuges and conveyed pneumatically to sludge incinerators. The latter are of the multiple hearth circular type, in which separate zones are provided for low temperature drying previous to high temperature burning. The ornamental chimney houses a stack for the incinerator gases around the outside of which there is an annular space through which the plant ventilating system exhausts foul gases arising from the treatment processes.

The plant effluent will be sterilized with chlorine before its discharge into the river, which is 180 ft. deep. The deep river channel will serve as the depository of the incinerator ash. Operations are expected to start in March.

Penstock Contract Let For Grand Coulee

Contract for the manufacture and delivery of more than 8,000 tons of steel penstock pipe to be installed in Grand Coulee has been awarded by the Secretary of the Interior to the Western Pipe & Steel Co. of California on its bid, lowest of three, of $1,457,000. The pipe covered in the contract is too large to be shipped by railroad to the dam site, and the contractor will be required to erect a fabricating plant near the dam. A site for the plant is offered at the government siding 3½ miles west of the dam.

The contract covers fabrication of eighteen pipes 290 ft. long and 18 ft. in diameter; three pipes 290 ft. long and 72 in. in diameter; and twelve comparatively short pipes 14 ft. in diameter. The 18-ft. pipes will be installed in octagonal holes left in the dam and later will be embedded in concrete; each will feed one of the turbines which are to be installed in groups of nine in the two power houses at either side of the downstream face of the dam. The 72-in. pipes will feed small turbines in the west power house which will operate generators to provide power for use at the dam site. The 14-ft. pipes will be installed in the pumping plant at the west side of the dam to serve as inlets for the pumps.

All of the penstocks and pump inlet pipes will be of welded plate steel construction. The contractor has 1000 calendar days in which to complete the work, although various parts of the pipe must be ready at stipulated intervals in advance of completion, beginning in 255 days.

Canadian Engineers Well Employed

Annual meeting of Engineering Institute of Canada finds few of its members are unemployed

Committee reports delivered at the 52nd annual meeting of the Engineering Institute of Canada and the retiring address of President Desbarats revealed that the institute has been able to do away with its non-active membership list because of improved employment conditions throughout the Dominion. Practically none of the membership is now unemployed. This has led to an increase in the active membership from 4,213 to 4,536.

The financial operating returns, however, showed a small deficit on the year's work. Since this is one of a series of such deficits, action was called for in order to insure a better financial condition in the future.

The E.I.C. Catalog, a volume of trade information and reference data which the institute has sponsored and published for several years, has been discontinued as an institute publication, it was announced. The catalog has been transferred to a private concern. A committee is at present considering all institute publications with a view to improvement and alterations.

Officers elected

J. B. Challies of Montreal was elected president of the institute at the meeting, which was held in London, Ont., Jan. 31-Feb. 2.

Vice presidents elected were: E. V. Buchanan, of London, for Ontario; H. O. Keay, Three Rivers, for Quebec; and R. L. Dunsmore, of Halifax, for the Maritime Provinces. The council, at a later meeting, nominated J. A. Duchastel de Montrouge of Montreal as treasurer of the institute; this post is filled by the council and not by election at large. Mr. Montrouge, a graduate of L'Ecole Polytechnique of Montreal, is at present assistant port manager of the Port of Montreal under the National Harbour Board of Canada.

John B. Challies, the new president of the institute, is one of the four assistant general managers of the Shawinigan Water and Power Co. of Montreal. After completing his education at the University of Toronto, from which he holds the degree of C.E., Mr. Challies began his career with the Topographical Surveys of Canada at Ottawa and later occupied a number of federal engineering positions including that of chief hydraulic engineer for the Department of the Interior and first director of the Dominion Hydrometric Survey. He was one of the founders of the Professional Institute of Civil Servants and has represented the Canadian government in various international engineering meetings. He left the federal service in 1924 to join the Shawinigan company.

Mr. Challies has held numerous posts in the institute and was closely associated with the early years of the institute after it developed out of the Canadian Society of Civil Engineers. He was elected to the council in 1920 and was chairman of a special committee on policy which recommended important changes in the by-laws. He served as vice president in 1922 and held office as treasurer from 1935 to 1936. He has been a member of the committee on consolidation of the institute throughout its history.

JOHN B. CHALLIES
New President of E.I.C.

• • •

Gila River Crossing Contract Let

Contract for the construction of the Gila River crossing, which will carry the main canal of the Gila federal reclamation project across the Gila River canyon about 11 miles west of Yuma, Ariz., has been awarded to the Metropolitan Construction Co. of Los Angeles on its bid of $337,375. The bid was the lowest of seventeen.

The crossing will consist of approaches at either end and a siphon barrel 19.5 ft. in diameter and 2,120 ft. long built of reinforced concrete.

The main canal of the Gila project is a gravity canal which will carry water from the Colorado River, diverted at the Imperial Dam, 300 miles below Boulder Dam, to irrigate about 150,000 acres of desert near Yuma.

Private Firm Builds At Greenbelt

Limited dividend company's rentals are not to exceed ten dollars per room.

Ten low-cost prefabricated houses are being constructed at Greenbelt, Md., a resettlement project of the Farm Security Administration, by Parkbelt Homes, Inc., a private limited dividend housing corporation. The firm has leased about three acres within the community's residential area at an annual rental of $150 per acre and may be permitted to rent as much as 43 acres of additional land at a later date.

This constitutes the first step toward the expansion of Greenbelt by private industry which was contemplated by the Farm Security Administration in providing utilities and community buildings to accommodate about 3000 homes, although it built only 885 dwelling units. Several other private firms are negotiating for permission to build additional houses at Greenbelt.

The houses being erected by Parkbelt Homes, Inc. are one-story steel-frame dwellings with outer walls of asbestos cement board and inner walls of plywood paneling. Each has a living room, dining room, kitchen, two bedrooms, bathroom and utility room. The development is being financed by a loan obtained from the RFC under a mortgage insured by the Federal Housing Administration.

The cost of the dwellings is estimated at about $6,000, consisting of a direct construction cost of $4,100, utilities and improvement of land, $1,000, special equipment, $500, and financing and planning charges, $400. There will be no restriction on the income of occupants of the new dwellings, but rentals will be restricted to a maximum of $10 a room.

• • •

Structural Settlement To be Studied

The Philadelphia section of the American Society of Civil Engineers has organized a committee to make systematic observations of settlement of new structures in the Philadelphia area. Prof. G. Tschebotareff, Princeton University, is chairman; other members are Prof. Samuel T. Carpenter, Swarthmore College, Charles A. Flanagan, chief of the Philadelphia bureau of building inspection, C. de Moll, of the Ballinger Co., and A. R. Wilson, Engineer of Bridges and Buildings of the Pennsylvania R.R. The committee will begin work at once.

Dexter P. Cooper Dies at 57

Promoter of Passamaquoddy power project suffers heart attack in Boston

Dexter P. Cooper, consulting engineer, Eastport, Me., brother of the world-famous engineer, the late Hugh L. Cooper, died at Boston on Feb. 2, following a heart attack.

Dexter Cooper's name will always be associated with the ill-fated Passamaquoddy tidal power project to which he gave so much of his time, energy and financial resources.

Born in Rushford, Minn., in 1880 and educated in the local schools, Dexter Cooper began his engineering career in junior supervisory positions on works being built under the direction of his brother Hugh Cooper, who was nearly 20 years his senior. This included work in the West Indies and in Brazil. From 1902 to 1908 he studied engineering at the Royal Polytechnical School at Karlsruhe; returning to this country in the latter year he resumed engineering practice, in part independently and in part with his brother. Most notable of these latter engagements was that at Keokuk, Iowa, where he was in immediate charge of construction on that first great power plant on the Mississippi.

The Quoddy plan

About 1913 Mr. Cooper went to Maine as general superintendent for the Hydraulic Engineering Co., ultimately making his summer home on Campobello Island in the Bay of Fundy opposite Eastport, Me. At that time he became interested in the possibility of developing power from the great surge of tides through the narrow channels along the bay, but it was not until 1919 that he put forward a definite scheme for harnessing the tides in Passamaquoddy Bay, which lies almost wholly in Canada, and Cobscook Bay, Maine. That scheme would have cost upwards of $100,000,000. Details of the successive stages through which it went in subsequent years were given in our issue of April 23, 1936, p. 584. Its international character, great cost and the limited market for the vast amount of power that had to be sold to bring it even within the bounds of practicability proved to be insurmountable obstacles. After 16 years of effort Mr. Cooper had to compromise on the much smaller scheme to harness the tides in Cobscook Bay in Maine, for which the President, in 1935, authorized an initial expenditure of $10,000,000.

The smaller project was foredoomed to failure. Its dams and hydraulic structures were far too costly in relation to possible power output, no firm power could be produced from the tides alone, and a proposed pumped-storage plant to supplement the tidal plant turned out to be impracticable. Work on the project was continued for about a year and then it was abandoned with about $8,000,000 spent on small dams and preliminary work for the large dams.

Mr. Cooper has been inactive since the project was abandoned. The energy put into the problems involved in getting the work started proved to be a severe drain on his strength.

ICE JAMS FLOOD ROCKFORD

Ice, massing at narrow bridges in the Keith and Kent creeks during high water late last month, forced storm sewers to reverse their flow and turned manholes and intakes into street geysers. The creeks jumped their banks and flooded nearly 30 square blocks of the city with from 6 to 7 ft. of water causing an estimated property damage of $50,000 to $75,000. Only prompt blasting of ice by the city engineering department at bridges crossing Rock River prevented flooding of large residential areas.

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Pollution Control Asked In Massachusetts

The Massachusetts Department of Health has recommended to the legislature passage of legislation empowering that department to regulate the discharge of domestic sewage and industrial wastes into rivers. The department reports serious pollution in the Merrimac and Nashua rivers and partial pollution in six other streams.

The department recommends that it be given power to require that municipalities on the Housatonic, Connecticut, Merrimac, Hoosick and French rivers construct and operate treatment plants. The department also wants authority to forbid discharge of sewage into the Blackstone and Nashua rivers.

Most domestic sewage and all industrial waste is now being discharged into the Merrimac river without treatment, the health department reports.

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Restraint of Trade Charged Against Chlorine Makers

Nine companies manufacturing liquid chlorine have been charged with engaging in a combination and conspiracy, resulting in their fixing uniform enhanced prices, by the Federal Trade Commission.

Since 1930, according to the complaint, purchasers of liquid chlorine have had no regular source of supply except the companies named in the complaint, and since 1931 these companies have engaged in an agreement to fix and maintain uniform enhanced prices for a liquid chlorine and to divide the county into zones.

The companies named in the complaint are as follows:

Mathieson Alkali Works, Inc., New York; The Electro Bleaching Gas Co., New York; Solvay Sales Corp., New York; The Hooker Electrochemical Co., New York; The Columbia Alkali Corp., New York; The Diamond Alkali Co., Pittsburgh; The Belle Alkali Co., Belle, W. Va.; The Monsanto Chemical Co., St. Louis; Pennsylvania Salt Manufacturing Co., Philadelphia.

BRIEF NEWS

INVESTIGATION to determine whether a license is needed by the Thompson Falls plant of the Montana Power Co. on Clark Fork has been instituted by the Federal Power Commission. The order of investigation states that the plant appears to be located partly upon public lands of the United States.

A CONCESSION to build a 60-mile railroad between Revorma, Oaxaca, and Arriaga, Chiapas, where it will connect with the Pan American Ry., and to operate it for 50 years, has been granted by the Mexican government to the Compania Mercantil Industrial y Constructora.

FIRST CONSTRUCTION within the city limits of Los Angeles on the Colorado Aqueduct started Jan. 25 when the J. F. Shea Co. began excavation for a 17.4 mile section of the aqueduct distribution system. This line, part of the Palos Verdes cross-feeder will be made of welded steel pipe coated on the outside with ¾ in. of shotcrete and on the inside with a ½ in. cement mortar lining centrifugally applied. The cross feeder line will deliver water to the cities of Los Angeles, Compton, Torrance and Long Beach.

A MEMBER of a board of supervisors may not design or supervise construction of bridges within his road district unless he is a registered civil engineer, according to an opinion of Attorney-General Webb of California. The preparation of plans and specifications, the Attorney-General held, is not a regular part of the duties of a member of a board of supervisors, and if a member performs such activities he is practicing civil engineering according to the registration act.

ALL BIDS have been rejected on 750,000 barrels of low-heat portland cement for the Marshall Ford Dam by the Bureau of Reclamation. Bids were opened in Denver Jan. 10, and the lowest of four bids received was from the Trinity Portland Cement Co. of Dallas, which offered to deliver cement at a cost to the government of $2.01 per barrel. This offer was considered too high. New advertisements will be issued.

ENGINEERING and construction materials are considerably affected by new import tariffs put into effect by Mexico. The tariffs are for two periods; an increase of 75 to 100 per cent in the rate is effective until next April 30 and thereafter rates 25 to 50 per cent greater than those in effect last year will be collected.

Concrete to be Used On Elevated Road

Concrete instead of granite block surfacing will be used on the newest section of the West Side elevated express highway in New York City, Borough President Isaacs of Manhattan has announced. Use of concrete on this section, from Canal St. to Duane St., will save the city about $43,000, he said. The statement was made in connection with the award of the paving contract to the James Stewart Co.

Discontinuance of the use of granite block was recommended in 1936 by the Commissioner of Accounts, and a report was prepared by Walter D. Binger, Commissioner of Borough Works. The present contract was drawn up in accordance with the Binger report.

Court Upholds Legality Of Grand River Project

The Oklahoma Supreme Court, in upholding Feb. 1 the legality of legislation establishing the Grand River Dam Authority, cleared the way for the start of work on the $20,000,000 hydro-electric project. The authority, its powers established, immediately proceeded to get work under way.

A contract for excavation of the east spillway was awarded to M. E. Gillioz for $43,500, and a $34,675 contract for core drilling on the rock saddle which will form the spillway was awarded to Sprague & Henwood of Scranton, Pa. The authority hopes to advertise for bids on the main dam, an $8,000,000 job, by May 1.

Legality of the authority had been attacked in a taxpayers' suit on the grounds that the act setting up the authority constituted local legislation in violation of the state constitution and that the provision permitting the authority to issue as much as $15,000,000 in bonds, to be retired from power revenues of the project, violated a constitutional provision forbidding the state to incur debts of more than $400,000 without a referendum.

On the first point the court held that restriction of the operations of the district to certain counties in the state and the requirement that officers of the authority be residents of the county are reasonable and do not make the act local legislation. On the debt limitation question the court decided that the authority's bonds constituted a special fund secured only by the revenues of the project.

LABOR NOTES

A RESOLUTION favoring the 8-hour day was adopted by the Pacific Northwest Branch of the Associated General Contractors at its annual convention in Seattle. The resolution is directed at conditions in northwestern Washington where contractors are seeking new labor agreements in place of expiring contracts containing provisions for a 6-hour day. Agreements of the Seattle chapter and the Mountain Pacific Chapter both expired Feb. 1. The latter chapter is seeking to obtain a basic wage of 75 cents, as compared to $1 in the old agreement, and the right to replace men on the job with men of their own choosing rather than those sent by the union. The contract which the chapter is proposing would be similar to that signed by the Interior Construction Co. at Grand Coulee.

THE COLUMBUS Building Trades Employers Association, which has hitherto had contracts only with individual building trades unions, has requested the Columbus Building Trades Council to sign a general citywide agreement covering all trades.

OTTAWA plasterers will receive 80 cents an hour until Aug. 1 and 85 cents thereafter under the terms of a new agreement executed under the Ontario Industrial Standards Act. The agreement also calls for an 8-hour day and a 44-hour week and forbids overtime work without approval of an advisory board which was appointed to administer the terms of the agreement.

FIFTY EMPLOYEES of the city of St. Louis, laborers in the water department, have voted to affiliate with the Building Laborers Union Local 42, an A.F.L. organization. The water department employs about 90 common laborers.

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Excavation Record Set In San Jacinto Tunnel

Hard rock crews in the Cabazon heading of the 13-mile San Jacinto tunnel established an all-time record for single heading excavation in that tunnel during the month of January when they drove 920 ft. of main tunnel. The previous record for one month's excavation on a heading was 869 ft., November, 1937.

The best month's progress in the entire tunnel since February, 1936, was achieved in January with a total excavation of 1,433 ft.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN CONCRETE INSTITUTE, annual convention, Chicago, Feb. 22-24.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, annual meeting, Engineering Societies Building, New York City, Feb. 14-18.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, annual convention, Hotel Ambassador, Atlantic City, N. J., Feb. 16–18.

AMERICAN TOLL BRIDGE ASSOCIATION, annual convention, Hotel Chamberlin, Old Point Comfort, Va., Feb. 22-24.

BUILDING OFFICIALS CONFERENCE OF AMERICA, annual meeting, Willard Hotel, Washington, March 21-25.

AMERICAN SOCIETY FOR TESTING MATERIALS, regional meeting, March 9, and committee week, Seneca Hotel, Rochester, N. Y., March 7-11.

AMERICAN SOCIETY OF CIVIL ENGINEERS, Spring meeting, Jacksonville, Fla., April 20-23.

AMERICAN SHORE & BEACH PRESERVATION ASSOCIATION, annual meeting, Washington, D. C., April 19, and Jacksonville, Fla., April 21.

REGIONAL AND LOCAL

SOUTHWEST ROAD SHOW AND SCHOOL, annual session, Wichita Exhibition Building, Wichita, Kan., Feb. 22-25.

ARKANSAS ENGINEERS CLUB, annual meeting, Hotel Marion, Little Rock, Feb. 25-26.

NEW YORK STATE ASSOCIATION OF HIGHWAY ENGINEERS, annual convention, Hotel Martin, Utica, March 3-5.

IOWA ENGINEERING SOCIETY, annual meeting, Iowa City, Mar. 9-10.

NEW JERSEY SEWAGE WORKS ASSOCIATION, annual meeting, Stacy Trent Hotel, Trenton, N. J., Mar. 10-11.

SECTION MEETINGS, American Water Works Association:

New Jersey, New Brunswick, Feb. 15.
New York, Jamestown, Mar. 17-18.
Canadian, Windsor, Ont., Mar. 23-25.
Illinois, Decatur, April 5-6.
Indiana, West Lafayette, April 7-8.
Pacific Northwest, Spokane, May 19-21.

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Short Course

TEXAS A. & M. COLLEGE, twentieth annual water works short school, College Station, Texas, Feb. 14-18.

CLUB BECOMES COLLEGE

UNUSUAL engineering problems are involved in the reconstruction of this club building to fit it for college use. Originally erected by the National Town and Country Club in 1931 at a cost of about $2,000,000, the building has never been occupied except for certain store buildings on the street level. The 21-story structure has now been acquired by Fenn College, Cleveland, and will be rebuilt for school purposes.

The project is under the supervision of C. D. Williams, associate professor of the department of civil engineering.

Purchase of Railroads Proposed by Wilgus

William J. Wilgus, well known authority on railroad transportation, has proposed that the railroads of the country be taken over by a national transport authority. This proposal is made in an open letter published by the *New York Times* on Jan. 30. Col. Wilgus believes that none of the plans now proposed to aid the railroads can provide the capital required for needed growth and improvement in service, nor will they bring about the stabilization of the present vast investment of insurance and like funds in railroad bonds that is so essential to better business conditions.

Col. Wilgus proposes that a transport authority be set up headed by men of highest character representing railroad managements, employees, investors and the general public, and that this authority take over the railroads at a fair value, the authority issuing its securities to pay for them. Thus it would be possible to provide the country with a unified system of railroads with the least disturbance to their personnel.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

WITHOUT direct reference to President Roosevelt's recommendation that federal-aid highway funds be scaled down, Thomas H. McDonald, chief of the Bureau of Public Roads, testified before a hearing of the House roads committee that the present level of highway construction activity should be maintained for at least twenty years. By 1960, he stated, the free movement of traffic will require a federal-aid system enlarged from the present 223,000 miles to 260,000 miles, with much of the present pavement replaced.

Mr. McDonald also suggested that the committee give serious study to the possibility of acquiring wide rights-of-way for superhighways. After the road is completed parts of the surplus land could be sold at an increased price, thus helping to defray the cost of construction. He opposed the three-lane highway as being too hazardous, and recommended that pavement width be limited to two lanes unless the volume of traffic should justify jumping to four lanes.

RFC AID for the railroads seems imminent. Apparently the administration, alarmed by the decline of their bonds, has decided that railroads are about as vital to the country's economy as other things that have been or are being aided.

INDICATIONS are that John L. Savage will represent the United States at the conference on large dams to be held in connection with the next meeting of the World Power Conference.

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1937 Power Production Greater than 1936

Production of electricity in the United States during 1937 totaled 120,996,000,000 kw.-hr., an increase of about 9 per cent over the record-breaking year 1936, according to preliminary figures released by the Federal Power Commission. Of the total output, about 117,742,000,000 kw.-hr. were produced for public use and consumption, as compared with 108,159,890,000 kw.-hr. produced for such use in 1936.

Production of electricity by water power was about 43,707,000,000 kw.-hr., or 12.8 per cent more than in 1936. Hydro-electric power amounted to 36 per cent of the total output.

News Events of 1937 in Summary

Condensed review of principal developments in engineering and construction as reported in the news pages of Engineering News-Record

A FRAME OF REFERENCE for consideration of the past year is provided by this review of the outstanding events of 1937—a review which should also be useful for future reference. Notably revealed in such a quick scanning of the year are the decline and fall of PWA, the increased activity and militancy of organized labor, and the intense interest in housing.

Transportation

FIRST SAFETY RULES for trucks in interstate commerce were issued by I.C.C.—*Jan.*

PARKING METERS in Birmingham were held illegal by Alabama Supreme Court.—*Jan.*

TRUCK REGULATIONS in South Carolina were invalidated by the Federal Circuit Court of Appeals.—*Jan.*

CONTRACT for second tube of Midtown Hudson Tunnel was awarded to Mason & Hanger, sole bidders, for $8,764,000.—*Feb.*

FEDERAL AID allotment to Maryland was reduced one-third in March by the Bureau of Public Roads because the state had diverted gas taxes. The state restored the diverted funds in April and avoided the reduction, but in the same month New Jersey diverted $8,000,000 of highway funds, and the bureau reduced its allotment. The bureau announced in October that it would reduce federal aid to Massachusetts because that state too had diverted highway funds to other uses.

TRANS-FLORIDA CANAL was approved by the chief of engineers, reversing conclusions of the Board of Engineers for Rivers and Harbors and concurring with a special board of review.—*March.*

QUEENS-MANHATTAN midtown vehicle tunnel under the East River at New York City was put under contract to the Walsh Construction Co. for $21,300,000.—*July.*

JURISDICTIONAL conflict between Connecticut highway department and public works department was brought into the courts by a road users' association.—*Sept.*

UNIFIED TRANSIT plan for Chicago was presented by city officials.—*Oct.*

CANCELLATION of 1939 instalment of federal aid to highways was recommended to Congress by President in November, but Congress took no action during the special session, and the state apportionments were announced by the Secretary of Agriculture at the end of December, with a request that states make no commitments until action by Congress on the appropriation.

Public Works and Planning

PWA BEGAN the year by cutting 2,000 men from its staff. Use of relief labor was promoted by the form of an unusual grant to Pennsylvania, under which the state received 133⅓ per cent of the amount it spent for relief labor on a state building program. The 45 per cent grant system was abandoned by PWA in March in favor of individual negotiations with sponsors in order to encourage the use of relief labor. By April, PWA allotments were revealed as having nearly stopped as a result of this policy, and the city of Cincinnati dropped all its applications for PWA aid.

The Public Works Administration was extended by Congress in June with a provision limiting future allotments to projects for which applications were already on file. The order requiring relief labor on projects was revoked and the 45 per cent grant system restored, whereupon Cincinnati renewed its applications for PWA grants. Rapid allotment of $113,035,000 in grants and $58,006,000 in loans to 1,253 projects was terminated in September, and the President announced that no more allotments would be made for the present, asserting that the need for pump priming had ended. PWA closed its state offices and arranged to supervise projects still under way through seven regional offices.

A DEPARTMENT of public works in the federal government was recommended by the President in his January message to Congress on governmental reorganization.

VALUATION of private land taken for Grand Coulee Dam, a Circuit Court of Appeals held, should not be computed on the basis of its potential use as a dam site.—*Feb.*

LONG-RANGE PLANNING of public works was urged by the President in a message to Congress in February, and in a message delivered in June the President recommended that seven regional planning and construction authorities be set up covering the principal water systems in the nation. Bills embodying the recommendations were introduced by Senator Norris and Representative Mansfield.

A TVA DAM at Gilbertsville, to cost $112,000,000, was authorized by the Senate.—*May.*

Failures and Accidents

WORKING PLATFORM under Golden Gate Bridge fell through safety net, killing ten men.—*Feb.*

GAS EXPLOSION wrecked a school building at New London, Tex., killing 455 children and teachers.—*March.*

A MANSLAUGHTER verdict was returned against six men as the result of the collapse in June, 1936, of an apartment house being built in the Bronx, New York City.—*March.*

WYANDOTTE COUNTY DAM over Marshall Creek, WPA-built earth fill structure in Kansas, failed during construction by a slump of downstream half believed due to foundation failure. An investigation was started.—*Sept.*

SHIELD BLOWOUT in Detroit sewer tunnel killed five men.—*Sept.*

FLOOR FAILURE of old Milwaukee building killed five men.—*Sept.*

HILLSIDE in Elysian Park at Los Angeles slid, burying a highway and destroying a viaduct.—*Nov.*

COFFERDAM failed at Port Stanley, Ont., and killed eight men.—*Dec.*

Labor

WAGE INCREASES on the San Jacinto Tunnel of the Colorado Aqueduct resulted from negotiations with the C.I.O. in March, but union demands for seniority rights were denied. In July the Metropolitan Water District of Southern California, owner of the project, refused to enter into a closed shop agreement with the C.I.O., and a strike was called on the tunnel in August, the union seeking recognition and reinstatement of men allegedly discharged for union activity. The strike was defeated.

F.A.E.C.T., a union of engineers, obtained wage increases for engineering employees of the New York World's Fair in March. The union affiliated with the C.I.O. in May and received a subsidy from the C.I.O. to finance an organization drive in July. At the union's third annual convention in October it was revealed that the drive had brought membership to 6,000.

WAGNER LABOR RELATIONS ACT was upheld by the Supreme Court in April. New York State passed a "Little Wagner Act" covering intra-state commerce the following month.

C.I.O. ORGANIZATION of labor on western reclamation projects resulted in: union recognition on the Roza project; strikes at the Gila project, the Intake and the Gene Wash pumping plants of the Colorado Aqueduct, and at Parker Dam.

Contractors on the pumping plants abandoned work until fall, and work was resumed at Parker Dam with A.F.L. labor. —*April.*

WAGE AND HOUR regulation was called for by the president in a message to Congress in May. At the same time the Black-Connery labor standards bill was introduced. The bill was passed by the Senate in July in a form creating a labor standards board authorized to set standards, down to 40 hr. per week and up to 40c. per hour.

BOCA DAM work was stopped by the contractors in July to forestall C.I.O. organization. After an attempt to operate with A.F.L. labor the job reopened in August under an interim agreement between A.F.L. and C.I.O. pending a vote of the workers. The election, in September, resulted in a victory for the C.I.O., confirming a contract with that group.

M.W.A.K. Co., contractors on the Grand Coulee Dam, signed a closed shop agreement with the A.F.L. in July. The low bidders on the high dam contract, Imperial Construction Co., signed a closed shop contract with the A.F.L. in December.

A.F.L. CARPENTERS and electricians declared a boycott on materials produced by C.I.O. labor.—*Aug.*

ASSOCIATED GENERAL CONTRACTORS voted to set up a department of labor relations with advisory powers.—*Oct.*

Power

T.V.A. POWER PROGRAM, expansion of which had been enjoined by Nashville federal court in December, 1936, was permitted to go ahead in Georgia by action of the Atlanta federal court in January. In May, the injunction was set aside in its entirety by a U. S. Circuit Court of Appeals pending a decision on the merits of the case.

A POWER POLICY for Bonneville dam and other federal projects was sought by the President in January in appointing an informal committee of government officials to study the problem. A bill to govern the administration of Bonneville dam and power plant was introduced in February; it placed control of power sale and generation in an administrator and left control of navigation to the U. S. Engineers. The bill was passed in July, giving the administrator authority over sale and transmission of power and putting operation of both dam and power house under the U. S. Engineers. In October, J. D. Ross was appointed administrator.

RAKER ACT was invoked by Secretary Ickes in requesting the Department of Justice to initiate a court review of the sale of Hetch Hetchy power by San Francisco.—*March.*

FEDERAL LICENSING of a proposed hydro project on the Yadkin River was demanded by the Federal Power Commission in September, although the site is upstream from a number of existing unlicensed dams. In the following month the commission began an investigation of existing dams on the Yadkin River to determine whether they should be required to obtain a federal license, and shortly afterwards expanded the investigation to cover all existing hydroelectric plants on federally controlled streams.

Government and Industry

DUST CONTROL code was approved by New York State a few days before a silicosis compensation law went into effect. —*April*

INCOME of contractors on the Bonneville project may be taxed by the state, the Oregon Supreme Court held in April, and the U. S. Supreme Court, in December, upheld state taxes on contractors on federal flood control and navigation projects. As a result, a call for bids on Crooked Creek Dam, a federal project in the Ohio system, issued in December, contained a provision that any state taxes imposed on the contractor after the opening of bids would be absorbed by the government.

CHARGES of restraining trade and price fixing were made by the Federal Trade Commission against manufacturers of cast iron pipe and blueprint paper in April, against manufacturers of concrete pipe in May, and against cement manufacturers in July.

IDENTICAL bids on steel purchased by the government, the Department of Justice found, were not the result of collusion but of the basing point price system.—*April.*

ORDERS to cease and desist from practices in restraint of trade were issued by the Federal Trade Commission against manufacturers of valves and piping in May and against building supply dealers in December.

NEW BUILDING CODE for New York City was passed by the Board of Aldermen.—*July.*

Water Use and Control

UNPARALLELED FLOODS in Ohio and Mississippi River resulted from continued heavy rainfall in the Ohio Valley. The Ohio exceeded previous records in many places by 6 to 15 ft. Large sections of all cities below Cincinnati were submerged, several cities were completely evacuated, and martial law prevailed throughout the valley. The new flood control works on the Mississippi met their first major test; Cairo stayed dry by raising levees 2 ft. above project height, and, though flood levels down to Helena exceeded 1927 figures, little damage was done in the Mississippi Valley.—*Jan.*

WATER SUPPLY was held to be an essential government function and salaries of New York City water officials were therefore held exempt from federal taxation by the U. S. Supreme Court in the suit of W. W. Brush.—*March.*

DELAWARE AQUEDUCT of New York City's water supply system was put under construction.—*March.*

CENTRAL VALLEY construction work began with the award of the contract for the Contra Costa Canal.—*March.*

SARDIS DAM bids were rejected as being too high, and the U. S. Engineers decided to build the dam by day labor.—*April.*

SPECULATION in Columbia Basin land was prevented by a bill passed by Congress.—*May.*

FLOOD CONTROL PLAN for Ohio and Mississippi Valleys to cost $800,000,000 was proposed to Congress by chief of engineers.—*June.*

CONNECTICUT and Merrimack river interstate flood control compacts were ratified by all states involved in July. Opposition to the compacts was expressed by the Federal Power Commission, on the ground that they involved surrender of federal interests in water power resources, and in August the President echoed this opposition. Congress refused to ratify the compacts.

FLOOD CONTROL operations were held up by federal refusal to start work on any project unless all money had been appropriated. An exception was made in favor of a number of Pittsburgh flood control projects.—*Nov.*

LOW BID on Grand Coulee high dam was offered by a combination of M.W.A.K. and Six Companies, Inc.—*Dec.*

Housing

WAGNER-STEAGALL housing bill was introduced into Congress in February, providing for $1,000,000,000 in loans to local housing authorities over a three-year period and an annual federal rent subsidy. The bill passed in August with the amount of loans scaled down to $500,000,000. In October Nathan Straus was appointed administrator of the U. S. Housing Authority, set up by the bill, and the authority absorbed the PWA housing division. Tentative allotments of funds to the local authorities were made in December.

THE PRESIDENT appointed a committee in November to seek means to stimulate private dwelling construction, and in the same month legislation to stimulate private building by extending and liberalizing the mortgage insurance activities of the Federal Housing Administration was proposed by the President in a message to Congress, and legislation was introduced.

Pollution and Treatment

LONERGAN and Barkley-Vinson stream pollution bills were introduced in January; the latter provided for loans for pollution abatement work but lacked compulsory features of the Lonergan bill. The Barkley-Vinson bill was passed by the House in January; it passed the Senate in August with amendments incorporating compulsory features. A conference committee began a search for a compromise between the two conflicting versions.

CONTAMINATED water in a Dallas suburb caused 3,000 cases of dysentery.—*April.*

POLLUTION of Pennsylvania streams except as permitted by the Sanitary Water Board was forbidden by the State legislature.—*July.*

ACTIVATED SLUDGE, INC. was awarded damages of nearly $5,000,000 against the city of Milwaukee in August by a U. S. District Court on the ground that the city had infringed patents on the activated sludge process.

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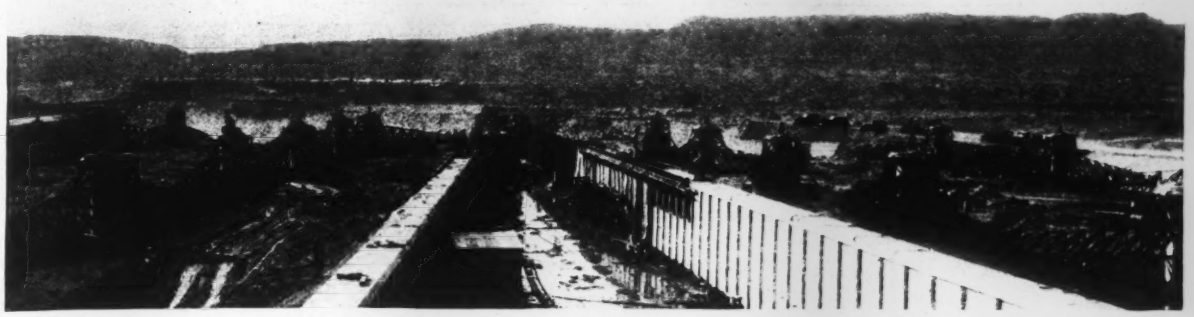


INFLUENT CHANNEL AND REVOLVING SCRAPERS AT THE DESILTING WORKS FOR THE ALL-AMERICAN CANAL

An Editorial Review of 1937

ENCOURAGING PROGRESS was recorded by the engineering arts during 1937, but industry and business did not do as well. The four years of recovery since the economic and financial breakdown of 1932 came to an end. Beginning with promise, the year was soon clouded by confusion at home and abroad, with resultant decline in confidence, business and values that reached a low point in December. Nature did not contribute to this confusion, for it brought good crops and weather; the only major disaster was the great Ohio Valley flood storm in January. Man, however, contributed strike violence at home and wars abroad, which intensified the uncertainties resulting from a wave of overbuying and price inflation that began in 1936. The labor disturbances noted in this review a year ago continued. Official laxity in maintaining order, divided councils at Washington, and punitive taxation helped to undermine confidence. Building declined in early summer, industrial demand waned soon after, and the mid-year slump turned to sharp depression by winter. These events determined the fortunes and are likely to influence the prospects of construction.

Construction Gains

AGAINST THE SEVERE DECLINE of the second half of the year, construction made a small gain over 1936—some 4 or 5 per cent. The volume of private construction passed that of public construction for the first time in six years, mainly because of factory expansion and improvement, which reached and perhaps slightly exceeded the replacement demand. No aid was obtained from utility and railway construction; legislative handicaps deterred utility expansion, while urgent economy reasons shut down railway improvement almost completely by midyear. Housebuilding suffered early from the general loss of confidence, and ended the year with only moderate advance over 1936. The construction deficit accumulated during the depression increased further, and undoubtedly will make itself increasingly felt as an impulse toward revival of building. Construction is still below two-thirds of normal.

1938 Prospects Fair

EXTENSIVE NEED for new construction dominates the 1938 outlook in spite of 1937 discouragements. Financial conditions are favorable; there is much money to invest, waiting only on renewed courage of investors to venture, and the prospects for 1938 construction therefore are fair. As in the past two years, rehabilitation of manufacturing plant constitutes the most promising item; many expansion plans are known to be ready for work. Housebuilding, now at the 200,000-unit level, less than a third of the annual replacement demand, is bound to see vigorous activity as soon as the individual citizen can once more look ahead through the fog.

Public works should barely hold their level even with new reemployment undertakings. Favoring circumstances may start up a substantial amount of utility work, normally an important item of the construction total. All told, despite the uncertainty as to wage conditions and labor attitude, it seems a fair guess that with reasonable return of confidence 1938 will show a substantial construction advance over the year just closed.

PUBLIC AFFAIRS

Large Public Works Decrease

FORT PECK AND BONNEVILLE construction drawing to a close, no new public superworks entered the field during the year except Central Valley and in qualified form Columbia Basin—the latter only through the decision to proceed with the high dam on completion of the contract for the base section. From the construction point of view both Central Valley and Columbia Basin, however, are aggregations of many individual works rather than single great structures or enterprises. As no projects of exceptional magnitude are in sight it may be that the era of emergency construction of superworks has ended.

National Policy Trends

PUBLIC POLICY in its effect on construction and engineering has rarely been as prominent as in 1937. All the major issues of governmental policy reacted on construction directly or indirectly. Increased taxation, use of taxation for regulative or punitive purposes as through the undistributed-profits tax, continuing governmental deficits in defiance of budgets, and social-betterment objectives of constantly shifting aspect, induced discouragement of enterprise. Clash of national and state jurisdictions was intensified, checking engineering planning and construction; progress on both stream-pollution abatement and flood control was inhibited by such governmental controversy. Finally, near the close of the year the President asked Congress to abrogate the authorized federal highway-aid allotment for the year beginning next July. This recommendation subsequently was made more drastic by a proposal to turn the saving over to relief workers, regardless of the normally employed workers thereby thrown out of a job.

Unemployment and WPA

ENCROACHMENT of the WPA work-relief system on the construction industry increased rather than diminished during the year, a fact that together with the non-constructive trend of other governmental policies makes the gain of construction the more noteworthy. The principle announced at the formation of WPA that relief work would be confined to jobs below $25,000 in cost and outside the normal range of local public-works construction, was finally thrown into the discard. Schools, sewers and other necessary works in cities able themselves to finance the cost of these works were built in increasing volume, the result being to compete with free construction labor and with contractors. At the same time the WPA accomplished little in restoring relief workers to normal employment; arbitrary decrease of WPA rolls during the first half of the year gave way to rapid increase in the second half, and the inroads of the WPA system on the construction industry were not counterbalanced by progress in the direction of normal reemployment.

ENGINEERING AND CONSTRUCTION

Science and Art

THE SUBSTANTIAL ADVANCE in engineering knowledge that characterized the year is considered in a number of articles in this issue, and only brief mention of a few developments is necessary here. Plate-girder and rigid-frame design research promises usable results soon. Model testing in both the structural and hydraulics field continued as accepted procedures, to the certain improvement not only of specific designs but of theoretical knowledge as well. In the field of concrete the Joint Committee's work in developing design procedures for applying the elastic theory should have a beneficial effect; its final report should be ready soon. Outstanding among the year's research results were the University of Illinois findings on fatigue strength of riveted joints; their application to design procedure is yet to be worked out. The year brought forth no sensational developments in materials research or application. Metal joint connectors for timber structures and wider acceptance of reinforced brickwork gave these two materials increased importance. In cement, the principal development was the publication of four federal specifications covering normal portland, high-early-strength portland, moderate heat and sulphate-resistant cements; heretofore the federal government has adhered to the single standard. Soil as a material was again the object of much dividend-paying research, and in all embankment and subgrade work the use of soil analysis and compaction was extended. Lack of proper soil studies was at the root of a serious dam foundation failure in Wyandotte County, Kan. In New York,

a special method of drilling foundation piles into sockets in the bedrock was shown to greatly increase load capacity.

Professional Matters

UNIONIZATION of engineering employees stands out out as the most significant happening in the year's professional record. The two principal unions in the engineering field claim a gain of some 3,000, bringing their total membership to 11,000. Subprofessional men are in the large majority. The movement is particularly strong in the Pacific Northwest, in some of the North-Central states, and in New York and a few other large eastern cities. Engineering employment conditions were good throughout most of the year, and employment services were looking for men. Late in the year, however, marked unemployment became noticeable. Completion of such large engineering operations as the Pennsylvania Railroad electrification threw many men out of work during the latter months of the year.

The Contractor's Position

CONTRACTORS have had no easy time since the start of the depression. Lack of work created ruinous competitive conditions that forced prices down to a no-profit basis and even lower. Many firms fell by the wayside in this process, which eased the competitive situation somewhat, but recovery of construction volume was so slow that prices did not rise to a reasonably profitable level. Especially during 1937 increased taxes and overhead largely wiped out the economies resulting from improved efficiency and better construction technique, while rising wages and materials prices carried prime costs upward. Regulatory measures and labor troubles have sorely beset the contractor, but his chief menace comes from the growing tendency towards day labor operations and toward competition by the WPA. At present there are 1,900,000 persons on WPA rolls, most of whom are engaged in operations normally done by contracting forces. The present position of the contractor is not a happy one.

Construction Labor

LABOR RELATIONS proved to be the most perplexing of all contracting problems last year. Labor supply, apprentice training and union organization were all part of the big problem. Caught in the general unrest and the organization activities of industrial labor last Spring, construction workers made their first real drive to organize heavy engineering and highway operations beyond the limits of the larger metropolitan areas already unionized. The movement found contractors generally unprepared, divided in opinion and uncertain as to course of action. Some fought for and maintained the open shop; others took no concerted action; but most of them met the labor issue squarely by forming local associations to deal with labor units. Experience of the past year indicates that organization of engineering construction work is inevitable. The Associated General Contractors, many of whose members fought the closed shop to the bitter end, recognized the trend by setting up for the first time a labor relations division. The new attitude in contracting circles towards labor offers hope of solution of the problems of labor supply, apprenticeship, working conditions and wage rates.

Equipment Further Improved

DEVELOPMENT AND IMPROVEMENT in construction equipment continue at a steady pace. Displays at the recent Road Show, which summarized the recent progress in the equipment field, revealed three important trends: *First*, better engineering and design, especially notable in general form, better bearings and other details, use of alloy steels, and improved framing, largely welded; *Second*, greater adaptability of the various units and more precise operation, accomplished by increased power, easier control, and ingenious operating mechanism; *Third*, development of specialty machines to take care of the increasing number of special and refined operations demanded of the modern constructor—especially in roadbuilding. Improvement of small tools, materials and construction accessories has kept up with that of the heavier equipment.

RIVERS AND RECLAMATION

Nature Favorable

HALF A DECADE of severe drought experience, with serious effects on streams, water supplies and underground storage, was followed by substantially normal rainfall and weather conditions in 1937. As many cities have taken steps to add to their supplies where drought had revealed a shortage, and as the possibility or impossibility of supplementing deficient farm supplies by drawing from deeper wells has been given much study, the experiences of the drought period were largely liquidated before the beginning of the year. In respect to flood experience, however, 1937 added the sensational Ohio River flood to the Central New York flood of 1935 and the March flood over the entire Northeast in 1936. This succession of events might suggest that a wet period of years is beginning, but hydrologists disagree on the point.

Except for flood, 1937 was moderate in all natural phenomena, bringing no exceptional storms and no earthquakes or other destructive visitations.

River Development

THE great Ohio River flood of January had important bearing on the general status of river development matters. With its flood levels as much as ten feet above anything previously known, with Portsmouth, Louisville, Paducah and many smaller river communities partly submerged, and with hundreds of millions of damage, the necessity of comprehensive control planning for the whole river system of the Ohio became evident. In this flood also the 1928 lower Mississippi control project was shown to require extensive reconsideration and replanning. Nevertheless the recent rapid evolution of basin-wide river problems changed to something approaching stagnation; the only action was development of a plan for conserving and rehabilitating the Red River of the North. Legislation calling for division of the country into seven regions based on river systems failed of passage. Neither conservation nor flood control made progress, nor did stream pollution abatement move forward.

T V A Builds and Quarrels

LACK OF ENTHUSIASM for establishment of regional river authorities was undoubtedly due in part to continued bickering among the directors of the Tennessee Valley Authority and to the failure of that organization to demonstrate that it was working out a well-rounded plan for the development of the region. Only in dam-building did the TVA go forward consistently with a definite program. As the new year opens it is evident that the conditions which resulted in failure of the directors to act as a unit are approaching the state of a national scandal calling for Congressional action. Whether the large structure to control the Tennessee River at its mouth, the Gilbertsville Dam, is to be authorized and the Tennessee thereby made to assist in flood control of the Ohio and lower Mississippi was left in doubt.

Flood Control

THREE FLOOD YEARS, 1935, 1936 and 1937, set the stage for rapid progress in planning and building major flood-control works. The comprehensive act of 1936 that authorized studies of many river systems throughout the country for flood-control purposes seemed to assure such progress, but 1937 gave little evidence of accomplishment. Meanwhile the Ohio River flood contributed new data on flood runoff possibilities. A plan for controlling the river, drafted in a few weeks' time immediately after the flood, is admittedly tentative. No restudy or revision of the Mississippi flood-control plan was reported during the year, although the near submergence of Cairo and the imminent overtopping of levees at a number of points between the Ohio and the Arkansas in the January flood indicated the need for fundamental review of the existing plans.

New England and Los Angeles

CONTROL PLANS for the Merrimack and the Connecticut rivers were well worked out in 1937 following preliminary studies of the previous year, and in accordance with the 1936 act two interstate compacts were formulated. When work was ready to go ahead, however, the whole plan was scuttled by the Federal Power Commission, which objected to the compacts as standing in the way of federal control of power that might be produced at the dams. Some needed channel improvement work was carried out by use of relief funds and WPA labor. WPA flood-control work on the Winooski River in Vermont, begun before passage of the 1936 act, was carried to practical completion. Work on the upper Susquehanna was inaugurated. The largest single undertaking of local flood control, that in Los Angeles County, was continued on a relief-work basis. The Army Engineers also began work on Sardis Dam in the Yazoo basin.

Reclamation

A HUGE RECLAMATION PROGRAM that continues operations begun under unemployment-emergency allocations of the previous years maintained this national development activity at decidedly abnormal level during 1937, with expenditures of 60 to 70 million dollars as against 10 million or less average yearly reclamation expenditures before the depression. In 13 states, 35 reclamation projects were under construction, with 21 dams, of which six were begun during the year. More than 300 millions of dollars remains to be spent to finish works already begun, so that abnormal reclamation building may continue for a number of years. Addition of new projects indicates that there is no present prospect of returning to the former level of activity. The outstanding developments of the year were a definite beginning on the Columbia Basin project through the decision to call for bids for completing the Grand Coulee high dam, and award of first contracts on the Central Valley project—water diversion from the Sacramento to the San Joaquin valley. Both projects far exceed in size any prior reclamation undertaking. The 1,200,000-acre Columbia Basin project was found to present such dangers of land

speculation and exploitation that a special law was passed restricting irrigation rights to lands sold at official appraisal prices. This is a new addition to the reclamation law of this country.

RAILROADS AND POWER

Rail Transportation

THE RAILROADS reached a serious financial condition last year, which was reflected in absence of construction expenditures. In normal times expenditures to keep the systems in good operating condition amount to well over half a billion dollars annually, and the requirements for modernization and expansion add materially to this amount; but with 30 per cent of the railroad mileage of the country in the hands of receivers such expenditures have been cut to a minimum. A pending application of the railroads for a 15 per cent rate increase may perhaps improve conditions in 1938. Despite unfavorable conditions the railroads continued to add high-speed trains and extended their use of new type locomotives, including more powerful diesels and multiple-cylinder steam motors. Electrification of the Pennsylvania R.R. main line also was continued, the new work being westward from Paoli to Harrisburg.

Power Marks Time

FEW POWER PLANTS were built during 1937, despite steadily growing demand. This was due in large part to uncertainty as to federal policy with regard to power and utility holding companies. Energy sales passed all previous records, reaching more than 99,000,000,000 kwh, an increase of 10.3 per cent over 1936; but new installation of generating equipment did not increase proportionately. The added demand was largely met by increasing the energy output per unit of capacity. While some authorities hold that this indicates progress toward higher load factor, all are agreed that elimination of present uncertainty will release a large amount of new plant construction.

Laws and Federal Control

SIGNIFICANT HAPPENINGS in the power field included the Supreme Court's finding that the federal government through PWA may finance the construction of municipal power systems, and the later decision of a federal district court upholding the right of the TVA to generate and sell power. How far the federal government may extend its control over water power plant remains uncertain, no case testing the Federal Power Commission's assumed rights in this respect having yet reached the Supreme Court. The effect of uncertainty as to federal power policy is particularly apparent in TVA territory and on the Pacific Coast, where the first two 66,000-hp. units at Bonneville Dam are ready to go into service and where power development at Shasta Dam on the Central Valley project is proposed. Fear that there will not be a market for power from the latter plant has resulted in holding up approval of plans of the Pacific Gas & Electric Co. for the construction of six hydroelectric plants on the Feather River.

HIGHWAY PROGRESS

Roadbuilding Levels Out

DECLINE IN ROADBUILDING during 1937 from the emergency appropriation figures of 1935-6 signalized the inevitable leveling out from the peak of expenditure undertaken to relieve unemployment. Reports from all states to *Engineering News-Record* show about 30,000 mi. of state roads improved during the year, to standards ranging from grading and drainage to full paving. This is about 11 per cent less mileage than was similarly improved in 1936. Budgeted figures for 1938 are about 12½ per cent greater than 1937 expenditures. The income from motor-vehicle taxes in 1937 increased about 10 per cent; diversion to other uses than roadbuilding amounted to about $150,000,000. A slight check in the trend toward diversion was evident.

Changed Problems

INCREASED INTEREST in secondary and low-type roads would suggest an increase in mileage compared with main-road extension, but this is not confirmed by the records, for in the state systems secondary road work fell off in 1937 and main road work increased. A notable increase took place in the work of widening and resurfacing old surfaced roads; reports from many states indicate that this will be an increasing activity of 1938. In large measure, widening and resurfacing are bringing a change in type of surface. Bridges are becoming a major problem, as all states report many bridges obsolete though still structurally fit. The problem of financing an adequate bridge-renewal program is admittedly serious.

New Design Trends

ROAD DESIGN and construction was stepped up to much higher plane in 1937. Common practice accepted the principle of road design for 60- to

100-mile speeds, including longer curves, greater sight distances, wider traffic lanes and shoulders, wider and shallower ditches, and flatter side slopes. For four-lane roads, separation of opposing traffic lanes by barrier zones became accepted doctrine. Construction had the aid of better surfacing materials developed by research and increased experience. Of particular value in this field was the accumulating knowledge of soil mechanics as it relates to soil stabilization and the solidification of fills. The year saw fills and subgrade being prepared by methods developed for the highest types of water-holding embankments as well as by the use of cementing admixtures of various types. Drainage was advanced by new studies in subdrainage, and surfacing processes showed progress in control of quality and precision of workmanship.

Planning from Surveys

NO DEVELOPMENT of many years contains such great potentiality of service to road transport as do the planning surveys begun in 1936 and swinging into full progress in 1937. These comprise road inventories, traffic analyses and financial appraisals. At present 45 states are carrying them on, and in a short time facts on road conditions and transport needs never before available will be at hand. Long-time system planning is to follow.

Express Roads

IF the metropolitan parkway and the city-access superhighway are taken out of the express-road classification, it must be said that the United States has no express roads. The building of freeways for express transport along main shipping routes is so far only a matter of talk, which talk was more plentiful in 1937. City-access superhighways, however, increased substantially. Boston is outstanding with several new entrances. New York is completing its costly West Side express road, the Long Island parkways have been extended, and Detroit, Chicago, St. Louis and other cities have added to their ease of approach and by-passing by wide access and belt roads.

Grade-Crossing Elimination

FEDERAL grade-crossing elimination and protection provided for by the emergency relief appropriation in 1935 of $200,000,000 and by authorization of $50,000,000 each for the fiscal years 1938 and 1939 has made rapid progress. To the end of the year 3,519 crossing improvements had been undertaken under the emergency appropriation, including 2,031 eliminations by separation or relocation, 375 structures reconstructed, and 1,113 crossings protected by signals. The numbers actually completed are respectively 1,673, 306 and 449.

STRUCTURAL AND BRIDGE ENGINEERING

Large Bridges

ANY FEAR that nothing very important could happen to bridge building after the surge of technical advance that accompanied the great San Francisco bridges was soon dissipated by developments of 1937. First was the beginning of work on the Whitestone Bridge at New York, a 2,300-ft. suspension span which is to be built complete in the unprecedented time of 24 months. At Baton Rouge the long-planned Mississippi River crossing, whose pier depth of 180 ft. is to be second only to the Bay Bridge, got under way. Brought to virtual completion was the high-level cantilever over the Neches River below Port Arthur, Texas, a structure notable for its spread-leg steel-framed towers and its special wind design. The Marine Parkway Bridge at New York, opened to traffic, contains a 540-ft. lift span, the longest yet built. These four structures by themselves demonstrate that 1937 was not characterized by a letdown in bridge developments. Although total bridge contracts were some 15 per cent less than the previous year, they reached the impressive total of $125,000,000.

Some Trends

CONTINUOUS-SPAN DESIGN was more popular than ever in 1937. Particularly notable were continuous plate-girder layouts, some of unusual proportions, such as three spans at Frankfort, Ky., with a central span of 200 ft.; eight spans for the new Chain Bridge at Washington, D. C., totaling 1,350 ft.; and five spans at Topeka, Kan., totaling 900 ft., with a record-breaking main span of 217 ft. The longest single-span girder yet built—188 ft.—was placed in New York City's Henry Hudson Parkway. Grade-separation projects continued to be built in large numbers, rigid frames and flat slabs predominating. Evidence of a wider acceptance of open steel grid as bridge decking is contained in its use on a Sioux Falls reconstruction job—2,000 ft. long by 20 ft. wide—and on the Marine Parkway Bridge—1,700 ft. long by 40 ft. wide. Open-mesh and concrete-filled grid floors were also used in New England, where, as a result of the disastrous 1936 flood, the greatest bridging program that any region of the country has ever experienced was carried on. Large structures here are the Connecticut River crossing of two 600-ft. tied steel arches at Middletown, Conn.,

and the steel arch spans of about 425 ft. at Chesterfield, Oxford and Manchester, N. H.

Building Advance

INDUSTRIAL STRUCTURES occupied the building spotlight during the past twelve months. Not only did the volume of factory contracts soar to the second highest level in history but interesting technical developments accompanied the increased activity; commercial building, while almost as great in volume as industrial and nearly double the previous year's total, was still small compared with any reasonable normal, and lacked notable technical features. Among the factory design innovations were steel walls faced with colored porcelain enamel, welded rigid frames, welded cantilever trusses, riveted trusses of 303 ft. span, thin insulated walls of asbestos-cement units, and concrete columns resembling mushrooms or morning glories, using expanded-metal reinforcement. Appearance has become a primary instead of an incidental design consideration. The increase in the popularity of glass block both in industrial and commercial structures was notable. A special problem in the design of such structures is to provide for opening sections in the walls to facilitate escape of smoke in case of fire and to permit the entrance of fire hose.

Building Codes

CODE PROGRESS was notable. New York's code went into effect, Chicago adopted several important chapters of its revised code, and in New England a regional code based on the Pacific Coast idea was drafted by regional building officials. All of these codes give much greater opportunity for use of new processes and new materials than was available previously. Publication of the California state regulations governing school building which emphasize seismic design, was another important event; the regulations had been in force for a year previous and had governed the extensive school rebuilding in the Los Angeles area. In New London, Texas, a school was the scene of one of the most tragic accidents in our history, when 455 children were killed in an explosion of gas that had leaked into an unventilated cellar space. Several codes have been revised to make a repetition of the disaster impossible.

Housing

SUDDEN COLLAPSE from old age of a tenement house on Staten Island which took 19 lives emphasized the urgency of slum-clearance housing, a subject prominent in the 1937 news. And definite progress was recorded in this field with the virtual completition of PWA's 50 projects in some 35 cities and the setting up of the U. S. Housing Authority under a new Congressional act providing for loans and subsidy to municipalities for carrying on the work of slum-clearance housing. The federal government's other housing venture, the resettlement villages in Baltimore, Milwaukee and elsewhere, made a rather ignominous showing when the "low cost" houses were found to have required an outlay of about $8.000 each.

Homebuilding

RESIDENCE CONSTRUCTION proved disappointing, topping the previous 12 months by only about 10 per cent, whereas the rate of building during the first six months had indicated at least 50 per cent increase. Rising labor and material costs are credited with a prominent part in causing the slowdown. As the year ended various attempts at stimulation, principally by amending the National Housing Act to permit smaller down payments and to reduce interest rates, were under way. Unfortunately the virtual building boom which characterized the first six months of the year was accompanied by a considerable amount of jerry-building. On the other hand the Federal Housing Administration requirements that certain standards be adhered to when it insures the mortgage forced the lending agencies to insist upon better building.

CITY SERVICE AND DEVELOPMENT

A Transition Period

PURGED of many physical weaknesses by the depression, and having passed through a period of easy capital, our cities ended the year in generally excellent shape. Tax collections were good and a large majority of the municipal operating statements and balance sheets reflected a healthy state of affairs. The ending of PWA and the tapering off of WPA money in the latter part of the year put responsibility directly on the cities for carrying on their public works. Due to the habit-forming effect of dependence on federal financial stimulus it has taken time for the cities to resume initiation of improvement programs of their own. It is fair to assume, however, that the transition period is ended.

Water Service

DOMESTIC WATER SUPPLY facilities were augmented materially in 1937 in both quantity and quality. Returning industrial activity and demands of air-conditioning installations increased consumption figures, but summer peaks were met with

few water shortage complaints. Boston's Ware River supply is well along, New York City has made substantial progress on the Delaware supply, and Birmingham and Charleston joined with local industries in the development of additional supplies. Cities that have turned to distant sources to secure water include Fort Smith, Little Rock and Denver. Installation of treatment plants for large cities has advanced; Milwaukee's plant is ready to go into service and Chicago has at last made a definite move towards filtration by appropriating some money for this work. Cincinnati and Louisville are developing plans to protect their filter plants against floods. Automatic control of pressure-regulating valves, of station units, of reservoir levels and of filter equipment has progressed with the continued perfection of hydraulic and electrical devices. Treatment methods show a few novelties; the most promising item—colloidal clay for coagulation—is still in the laboratory stage of development. Taste and odor removal has become routine practice and water softening installations are on the increase.

Sewage and Stream Pollution

UNUSUALLY BRISK ACTIVITY marks the year 1937 in sewage disposal progress. Reflecting the impetus of federal aid, there were completed or under construction more major plants than in any past year; scores of small plants were also built. If one word can be used to characterize the design trends in these new plants, it is mechanization—mechanical aids and control devices being increasingly adopted as adjuncts to existing treatment plants. The number of plants which adopted sludge dewatering and incineration clearly evidenced the acceleration of a trend noted a year ago; however, sludge digestion held its popularity because of byproduct gas utilization. Interest in the preparation and marketing of sludge for fertilizer was renewed. An important decision was handed down in August, when Activated Sludge, Inc., won its patent infringement suit against Milwaukee, thus making the city liable for the payment of nearly $5,000,000. In a similar infringement suit against Chicago the courts also decided against the city. While steady progress was made in disposal of city sewage, industrial wastes remained a troublesome factor. Federal legislation for pollution abatement was stalmated in Congress.

Refuse Disposal

DISPOSAL OF GARBAGE with sewage has been the subject of laboratory study, short-time plant operations and much controversy during the past few years. That garbage from a large city can be ground up and carried through the sewer system has been established by St. Louis experience. Lansing, Mich., is building a sewage treatment plant with digestion tanks able to accommodate all garbage. This is the first full-scale installation of its kind. In the field of refuse incineration combustion control and efficiency are being bettered experimentally by grinding refuse to a uniform size for feeding to the furnace with mechanical stokers. Incinerator construction continued to gain, but at much slower pace than in the two preceding years. Notwithstanding findings of the U. S. Public Health Service correlating high incidence of trichinosis with centers where garbage is fed to hogs, hog farms are still the chief method of garbage disposal in this country.

Streets and Traffic

STREET IMPROVEMENT in 1937 was carried on largely with WPA funds and labor, and was confined to reconstruction and resurfacing. Some renovation of street design to greater width and flatter crowns was attempted, and inlets and catch-basins were improved. There were no changes in pavement type or construction technique, but big advance in closer control of materials and workmanship. Prohibition of parking in designated streets is being tried in New York since the first of the year as means of facilitating traffic; results to date, material reduction in travel time, confirm anti-parking experience elsewhere. In downtown Chicago traffic congestion has been eased by parking lots, basement garages (accommodating 18,000 cars) and multiple storage garages. In Philadelphia space has been provided under some office buildings for parking. San Francisco, flooded more than ever with traffic since the opening of its two big bridges, is widening its streets and restricting parking. Parking meters, a novelty two years ago, have been widely accepted as an aid in control of parking.

Inadequate Airports

GROWING REALIZATION of the inadequacy of our airports developed, despite the WPA expenditure during the year of nearly forty million dollars on airport improvement. New airplanes already building or projected can be accommodated with difficulty on the best of the landing fields, but the great majority of existing fields are completely obsolete. Cities which have gone into debt for these outmoded facilities are loath to make additional expenditures, at least until the aircraft industry indicates some end point in plane development. In the meantime debate continues in Washington on who shall be boss of civil aviation. Until the problem is definitely settled, the necessary airport improvement program must wait.

Construction Gains, Costs Rise

Last year's advance in private enterprise led by factory building overcame a decline in public works in spite of recession and carried the year 1937 five per cent in advance of the previous year

CONSTRUCTION in 1937 began at a strong pace that continued the consistent 1936 advance and reached a 15 per cent gain in July; it was slowed up by the business recession of the second half, which held the year's construction total to a gain of only 5 per cent over 1936. In the story of 1937 private construction enterprise is the hero, construction costs the villain.

Measured in dollars the estimated total of all kinds of construction in 1937 was $5,852,000,000, of which private construction was $3,046,000,000 and public works $2,806,000,000. The year was the first since 1930 to show private construction ahead of public works. The figures just given represent a gain over 1936 of 5 per cent in total and 24 per cent in private construction, against a decline of 10½ per cent in public works.

These comparisons are based on dollars measured against a rising cost scale. Structure volume, measured by the *ENR Construction Volume Index*, shows a 7½ per cent drop compared with 1936, as the Cost Index averaged 13 per cent higher than in 1936.

Construction recovery thus advanced 5 per cent if measured by dollars spent and receded 7½ per cent if measured by the structures produced. Taking 1929 construction as standard, 1937 carried the industry up to 62½ per cent in dollars and to 54 per cent in structure volume; taking the depression low as standard, it rose to 223 per cent in dollars and 169 per cent in structure volume.

Against this, general business (measured by the *Business Week Index*) was only able to hold its own in 1937 compared with 1936, standing at 70 per cent of 1929 in both years, or at 133 per cent of the depression low point. Manufacturing did better, with a 4 per cent gain for 1937 over 1936, according to the Federal Reserve Board Index; it reached 91½ per cent of 1929 and 173 per cent of 1932. The figures show clearly that construction still lags far behind manufacturing, though slowly gaining on it; the construction lag in turn contributes to the lag in recovery of general business.

TABLE 1 — ESTIMATE OF ALL CONSTRUCTION IN THE UNITED STATES

(Millions of Dollars)

	Public	Private	Total
1925	2,476	5,702	8,178
1926	2,670	6,208	8,878
1927	3,073	6,522	9,595
1928	3,480	7,100	10,580
1929	3,263	7,114	10,377
1930	3,363	5,695	8,058
1931	3,098	2,832	5,930
1932	1,918	921	2,839
1933	1,533	907	2,440
1934	2,373	731	3,104
1935	2,460	1,221	3,680
1936	3,140	2,450	5,590
1937	2,806	3,046	5,852

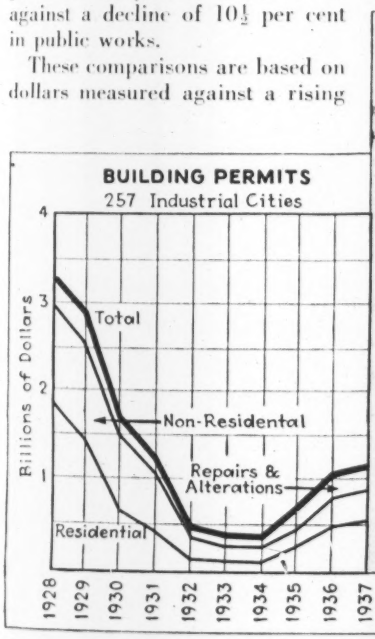


Fig. 1. Estimated dollar volume of all construction gained 5 per cent, private 24 per cent; physical volume dropped 7½ per cent.

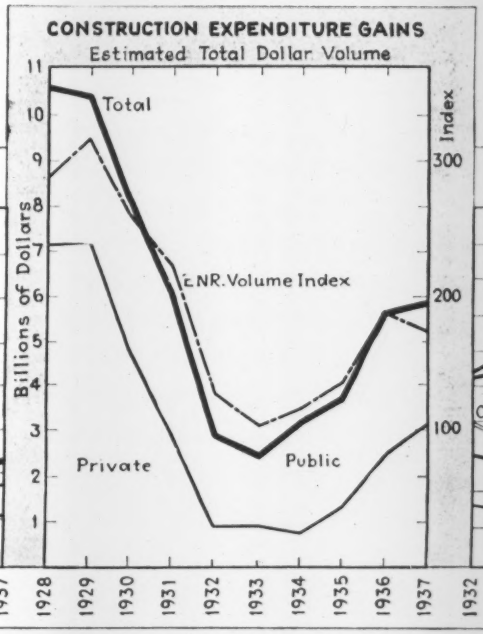


Fig. 2. New building construction recovery lags, both residential and non-residential, but alterations gain.

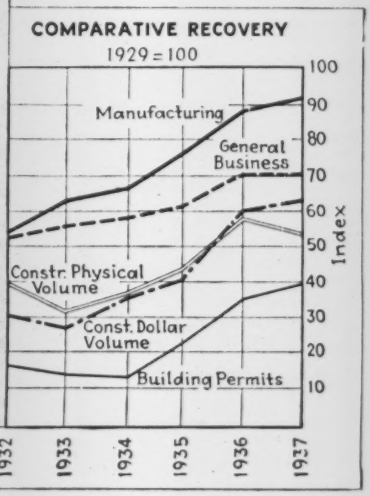


Fig. 3. Recovery of construction and building permits continues below that of business and manufacturing.

TABLE II — ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD IN 1937

Engineering News-Record *reports projects of the following minimum cost: Waterworks, excavation, drainage and irrigation,* $15,000: *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

52 Weeks — Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States 1937	United States 1936	% Change	Canada 1937	Canada 1936
Waterworks	5,521	60,410	5,156	8,190	10,766	14,406	104,449	92 478	+15	3,089	2,023
Sewerage	1,987	42,202	3,752	30,288	13,209	3,856	95,294	121 056	−20	1,448	2,008
Bridges, public	11,561	42,557	21,825	17,775	19,091	12,421	125,230	173,749	−27	7,198	5,104
Earthwork and waterways	1,471	19,266	11,343	11,323	41,485	25,465	110,353	181,685	−38	17,719	3,935
Streets and roads	16,989	87,329	73,618	93,622	98,903	44,076	414,537	483,475	−13	39,601	25,533
Buildings, public	18,167	129,571	36,689	61,755	53,513	33,703	333,398	435,926	−22	17,979	6,685
Unclassified, public	4,071	83,914	9,830	9,412	13,516	17,753	138,496	132,469	+ 7	6,296	3,443
Total public	**59,767**	**465,249**	**162,213**	**232,365**	**250,483**	**151,680**	**1,321,757**	**1,620,838**	**−17**	**93,330**	**50,711**
Federal government (included in above classifications)	5,552	44,036	24,794	29,784	52,571	48,851	205,588	319,538	−35	.....	.....
Private											
Bridges, private	209	5,849	837	270	594	100	7,859	14,067	−43	13	70
Buildings, industrial	25,292	193,328	52,131	109,512	48,957	48,078	477,298	309,477	+57	34,047	33,443
Buildings, commercial	24,099	323,587	18,211	47,974	21,595	24,503	459,969	274,784	+71	5,696	4,466
Unclassified, private	2,627	70,351	8,987	32,602	36,789	19,384	170,740	167,679	+ 4	2,422	5,203
Total private	**52,227**	**593,115**	**80,166**	**190,358**	**107,935**	**92,065**	**1,115,866**	**766,007**	**+48**	**42,178**	**43,082**
Grand total — 1937 — (52 weeks)	**111,994**	**1,058,364**	**242,379**	**422,723**	**358,418**	**243,745**	**2,437,623**	.....	**+ 4**	**135,508**	.....
Grand total — 1936 — (53 weeks)	**148,295**	**775,769**	**308,735**	**423,135**	**444,978**	**285,933**	.....	**2,386,845**	.....	.....	**93,793**

The reason for the lag in construction recovery is the slowness of building revival, shown in all the data. Thus, according to the building permit record of the Bureau of Labor Statistics for 257 cities, by the end of 1937 building had recovered only to 39 per cent of 1929; in detail, new residential building stands at 35 per cent, non-residential building at 33 per cent, and addition, alteration and repair work at 78 per cent. But the depression had hit building so severely that the 1937 figure, low as it is, represents more than three times the bottom figure (reached in 1933 and 1934).

Compared with 1936, building permits show gains of 12 to 13 per cent in 1937; the residential gain was 11 per cent.

The estimates of total construction, used here to measure the whole extent of construction activity, residential, industrial, commercial, public, are based primarily on values recorded by *Engineering News-Record*, which totaled $2,437,000,000 in 1937. This is a 4 per cent gain in dollar volume over 1936 and a 128 per cent gain from the record low of 1933.

Private engineering construction (this excludes small residential) made a 48 per cent gain over 1936 and rose to approximately fifty per cent of the recorded total 1937 construction volume. Industrial building set the pace, scored a 51 per cent increase over 1936 and made its second highest year on record, $177,000,000. Commercial building followed close behind, with a $160,000,000 year and 68 per cent gain over 1936. Steady gains were made in industrial and commercial construction throughout the 18 months ending in July, 1937. The second half of 1937 retarded these gains.

Public construction receded 17 per cent from its 1936 all-time record to $1,321,757,000. Federal construction declined from its 1936 figure by 34½ per cent, state and municipal by 13 per cent. Moving against this trend was a 13 per cent gain in waterworks, which established a high record of $104,500,000 for 1937, largely due to New York's Delaware River work.

Sewerage, bridges and public building all exceeded their 1925-36 averages, but dropped back from

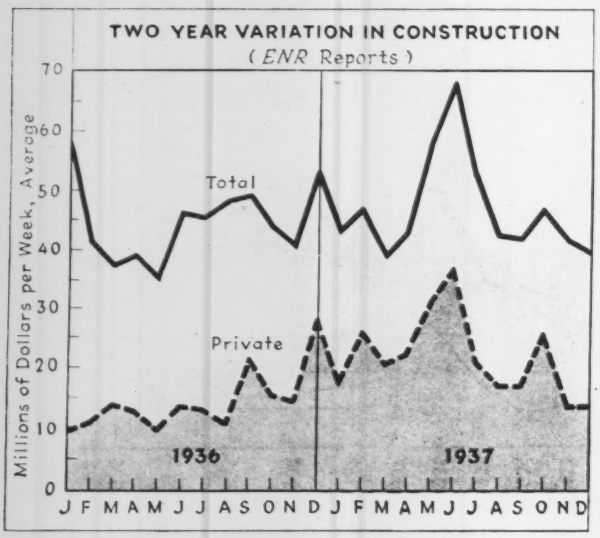


Fig. 4. Private construction rose to 50 per cent of 1937 engineering construction, increasing steadily until July, after which it fell back sharply.

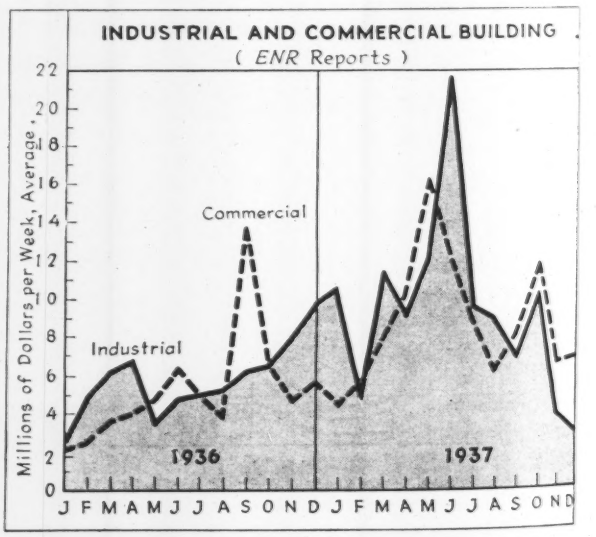


Fig. 5. Industrial and commercial building was industrial being headed for a record until the fall skid took place.

their all-time records of 1936 by 20, 28 and 22 per cent respectively, to $95,000,000, $133,000,000 and to $333,000,000. Street and road construction dropped 12½ per cent, to $415,000,000.

Geographically, *ENR* reports show that two territories gained over 1936: *Middle Atlantic* 39 per cent, *Mid-West* 2 per cent. Other territories declined: New England 23 per cent; South 20 per cent; West of Mississippi 18 per cent; Far West 13 per cent.

Construction per capita

The distribution of construction by geographical areas credits 32 per cent of the total to the Middle Atlantic states (New York, New Jersey, Pennsylvania, Maryland, District of Columbia, and Delaware). This concentration of construction activity contrasts with the population percentages of these states—23 per cent—and gives Middle Atlantic the highest per capita construction in the country, $36.95, compared with the 1937 national average of $19.88. The second highest per capita, $25.20, is Far West (California, Oregon, Washington, Nevada, Arizona, Utah, Idaho). The lowest is South, $9.54; New England, $13.70.

Per capita expenditures for specific types of construction show some illuminating facts. For example, the South spends for public work $6.39 per capita, or only 39 per cent as much as the Middle Atlantic states; it spends only half as much on private work, while Middle Atlantic spend 28 per cent more on private than on public.

Far west expenditures

Far West spends $15.68 on public work, only slight less than Middle Atlantic, but spends much less on private work, only $9.52 as against $20.70 for Middle Atlantic.

Sewerage expenditures range from 15c. per capita in the South to $1.47 in Middle Atlantic; street and road construction from a low of $2.08 per capita in New England to a high of $4.55 in the Far West; earthwork from a low of 18c. in New England to $2.63 in the Far West. Industrial buildings range from $1.92 in the states west of the Mississippi to $6.75 in Middle Atlantic; commercial buildings, including large-scale housing, from 71c. in the South to $11.30 in Middle Atlantic.

Materials and employment

Construction activity appraised by materials shipments shows 1.2 per cent gain over 1936 in cement, 7.2 per cent gain in fabricated structural steel, and 4 per cent gain in lumber. The materials shipment index average for 1937, however, shows a drop of 2.7 per cent. The first nine months saw consistently higher shipments than in 1936 for fabricated structural steel and cement, as did the first 6 months for lumber and the materials shipment index. These gains were offset by the lower shipments in the last quarter and half respectively.

Construction employment

Employment on construction in 1937 increased 40 per cent in Ohio over 1936, although throughout the country construction employment on state and federal highways declined 27 per cent from 1936 and was the lowest since the record was established in 1931. The seasonal pattern was the same throughout the year but on a reduced scale.

Employment in the building trades increased in 1937 to 75 per cent of all union members. This is the same union employment ratio that prevailed in 1929 and represents an increase from 33 per cent in 1933 and a 12

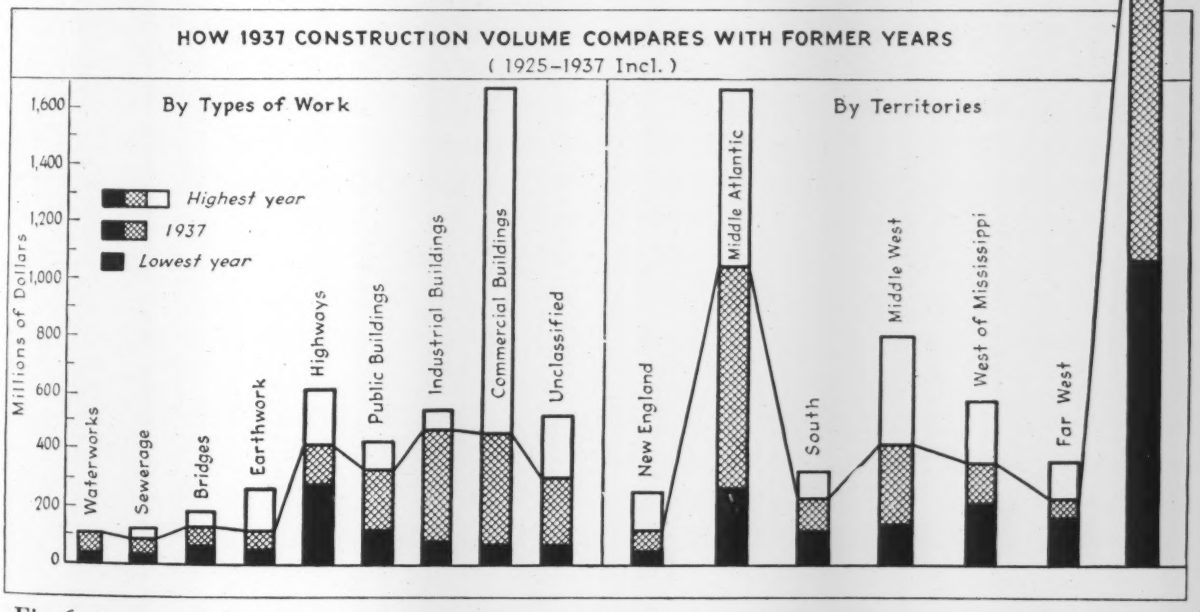


Fig. 6. Recovery by types shows waterworks breaking through previous high, industrial buildings challenging former record.

Fig. 7. Recovery by territories shows Middle Atlantic and South making largest gains, Middle Atlantic heaviest volume.

TABLE III — OUTPUT OF VARIOUS CONSTRUCTION MATERIALS FOR TEN YEAR PERIOD

Item	Basis	Unit	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937*	% Gain 37 36
Lumber	Production	Millions Bd.-ft.	34,142	36,886	26,051	16,523	10,159	13,961	15,039	19,539	23,445	24,257	3
Cement	Shipments	Thous. Bbl.	173,452	169,440	159,558	126,465	80,529	64,086	75,917	74,936	112,566	113,997	1
Steel ingots	Production	Thous. Tons	50,325	54,850	39,595	25,193	13,323	22,594	25,599	33,426	46,807	49,508	6
Fabrocated structural steel	Shipments	Thous. Tons	3,122	3,307	2,987	1,812	942	898	1,116	1,105	1,548	1,672	8
Fabricated steel plate	New orders	Thous. Tons	628	639	569	363	162	198	242	258	484	428	−12
Explosives	Shipments	Thous. lb	455,184	484,596	424,920	325,440	227,508	240,366	305,577	297,730	378,361	391,431	3
Common brick	Shipments	Millions	.....	.....	.....	.....	.....	.....	.....	952	1,720	1,881	9
Vit. paving brick	Shipments	Thousands	.....	.....	.....	.....	.....	.....	.....	62,528	96,001	90,555	−6
Prepared roofing	Shipments	Thous. squares	36,540	39,864	27,876	22,592	22,208	23,883	23,594	27,005	32,237	32,730	2

* Estimated totals.

per cent gain over 1936. The monthly figures follow the same seasonal pattern that materials shipments take—strong consistent gains over 1936 for the first nine months then a drop in the last quarter.

Employment in the building trades at 75 per cent and a gain of 12 per cent over 1936 compare with the all-union-trades employment ratio of 87.5 per cent and a 5 per cent gain over 1936.

Factory employment, based on 1923-25—100, stands at 100.3 for 1937, with a 9 per cent gain from 1936 to 1937.

Construction moves into 1938 with a number of factors favoring a moderate gain. New capital available for construction increased in 1937 above the amounts reported for 1936; motor vehicle revenue for highway purposes increased 8 or 9 per cent; state budgets indicate a 12½ per cent increase planned for highway construction; the organization to administer federal housing funds is shaping up and is assigning tentative allotments which enable the communities benefited to go ahead with their end of the financing.

Table IV — Engineering Construction Per Capita (*ENR* Reports)

New England	Population ,000 omitted	Public	Private	Total
New England	8,166	$7 33	$6 37	$13 70
Mid Atlantic	28,618	16 25	20 70	36 95
South	25,426	6 39	3 15	9 54
Mid West	25,297	9 19	7 54	16 73
West of Miss	25,594	9 81	4 22	14 03
Far West	9,674	15 68	9 52	25 20
U. S.	122,775	$10 78	$9 10	$19 88

	Middle Atlantic	Far West	South	U. S. Aver.
Waterworks	$2 11	$1 49	$0 23	$0 85
Sewerage	1 47	.40	.15	.79
Bridges, Public	1 48	1 29	.85	1.02
Earthwork	.67	2 63	.46	.90
Highways	3 05	4 55	2 80	3 37
Pub. Bldgs	4.52	3 48	1 43	2 72
Ind. Bldgs	6 75	4 97	2 05	3 91
Comm. Bldgs	11 30	2 49	.71	3 76

Industrial building construction has a $500,000,000 backlog of proposed work that can go under contract as corporate security markets improve and taxation uncertainties are removed.

State and municipal bonds continue to sell at low yields to a market that absorbs them as fast as offered. The principal brake on this source of capital is a reluctance of citizens in many communities to increase their bonded indebtedness. State and municipal work is still in a transition stage between federal financing and a return to financing by private investment and will probably so continue through 1938.

Construction costs, which had increased 10 per cent from January to December, 1937 and 22½ per cent from January, 1936, to December, 1937, leveled off during the third quarter of 1937 and have started 1938 with a decrease of almost 1 per cent.

These factors add up to a favorable total. Present conditions, therefore, point to a measurable gain for the first half of 1938 over the same months of 1937, a gain that with favoring conditions can reasonably be stepped up to 25 or 30 per cent for the year if tax and financing uncertainties are cleared up so that private construction may be encouraged to resume its recovery.

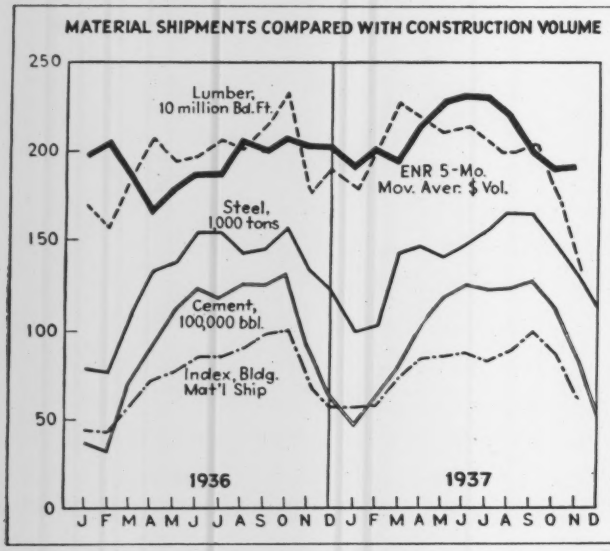


Fig. 8. Materials shipments showed moderate gains in 1937 with higher spring volume and sharper winter drop than in 1936.

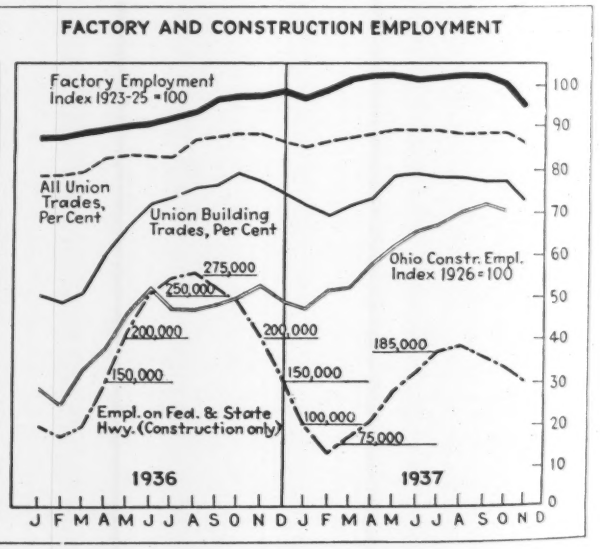


Fig. 9. Employment on federal and state highway construction dropped 27 per cent while other construction employment records gained.

More Money for Construction

Investment for construction gained substantially in 1937 but reached only a third of predepression volume

NEW productive capital for construction gained 37 per cent in 1937 over 1936. Largely responsible for this increase was the most substantial gain in private investment in construction securities since 1931. Private investment totaled $1,048,000,000 for the year, which represents a gain of 40 per cent over '36. It was divided between industrial, utility and railroad securities, $517,000,000, and state and municipal bond issues, $531,000,000; however, the former figure is more than double that of 1936—102 per cent gain—while municipals increased only 5 per cent.

Although this increase in construction funds looks favorable in percentage figures, the actual recovery toward predepression levels is low.

Federal financing of non-federal work, which has supplemented the private investment financing since 1932, tapered off in 1936 and 1937 and began the transition back to private financing.

Adding to the new capital shown in the charts below, the federal government in 1937 authorized $200,000,000 federal road aid, $471,000,000 for construction handled by regular federal bureaus, $1,100,000,000 for Works Progress Administration construction.

Not included in the new productive capital figures reported during the year, yet an important factor in highway financing, is the revenue collected by states from motor vehicle users, estimated at $950,000,000.

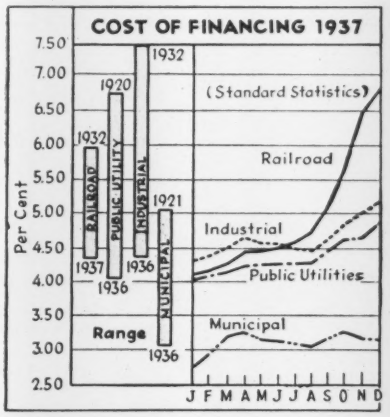


Fig. 1. Cost of financing construction touched bottom and started back up in 1937. Municipals held low average but corporate bond yields climbed.

Rent levels, investment market

In the building field an important factor in determining return is rent. Rent recovery in 1937 reached 94 per cent, while building costs were at 104 per cent of 1929 levels.

The future outlook for construction depends in large measure on the private investment market for construction securities. Through nine months of 1937 the market was good for both corporate and municipal issues. In the fourth quarter prices dropped for corporate issues, but the municipal market remained strong and absorbed issues as offered. Cost to municipalities of their financing continues to be the lowest on record, though industrial, railroad and utility bond yields climbed sharply in the last few months of the year.

TABLE I — CORPORATE, STATE AND MUNICIPAL FINANCING

(Millions of Dollars)

	Total Financing Inc. Refunding *			New Productive Capital		
	Corporate	State and Mun.	Total	Corporate	State and Mun.	Total
1925	$4,222	$1,400	$5,622	$1,966	$1,352	$3,318
1926	4,574	1,365	5,939	1,824	1,344	3,168
1927	6,507	1,510	8,017	1,784	1,475	3,259
1928	6,930	1,425	8,345	1,568	1,379	2,947
1929	9,376	1,431	10,807	1,758	1,418	3,176
1930	4,757	1,487	6,244	2,032	1,434	3,466
1931	2,371	1,256	3,627	787	1,235	2,022
1932	643	849	1,484	159	561	720
1933	380	520	900§	292	1,091‡	1,383
1934	490	939	1,429§	77†	1,011‡	1,088
1935	2,267	1,215	3,482§	47†	1,305‡	1,352
1936	4,632	1,117	5,749§	250	698‡	948
1937	2,337	902	3,239§	518†	738‡	1,256

* From Commercial and Financial Chronicle.
§ PWA Financing not included.
† Includes $237,000,000 RFC and PWA ans, '33. $55,000,000, '34; $9,000,000, '35; $807,000, '37.
‡ Includes $814,000,000 RFC and PWA loans and grants, '33; $580,000,000, '34; $808,000,000, '35; $164,700,000, '36; $207,000,000, '37.

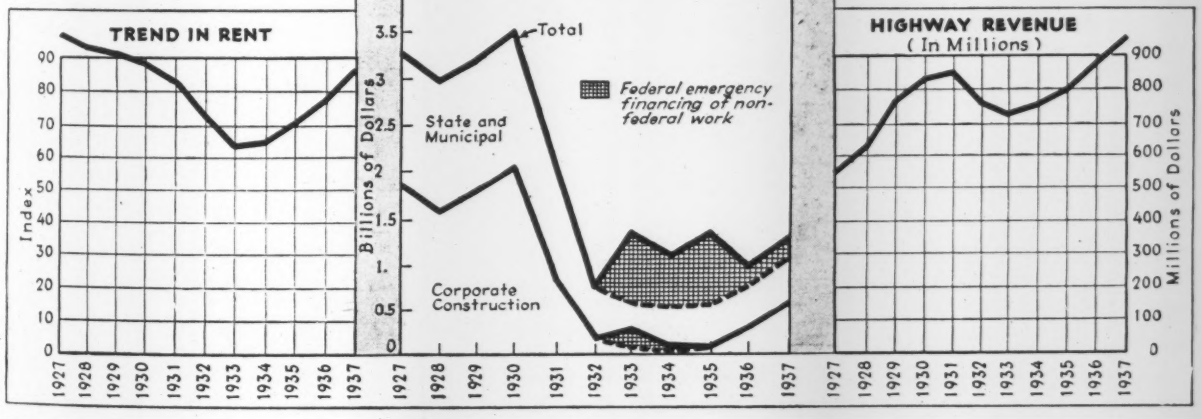


Fig. 2. Rent passed 1931 levels but recovered only 96 per cent of 1929 average.

Fig. 3. Private investment financing gain was shared by corporate and municipal securities.

Fig. 4. State revenue from motor vehicle for highway purposes gained 8 per cent.

Costs Steady After Sharp Rise

Climbing wage rates and material prices both contributed to higher construction costs in 1937 through July but leveled off during second half of year

Costs held the spotlight during 1937 as construction's bad actors. Beginning in July, 1936, at 204.40, the *ENR Construction Cost Index* climbed steeply and steadily for 12 months to 241.75 in July, 1937—an 18 per cent rise. After July, however, the rise flattened off, and the Index closed the year at 244.95.

The factors back of the year's increase are, in order of importance: common labor, steel, lumber.

Wage Rates—In coming out of the depression, common labor rates advanced at a more rapid rate than skilled. This was true in 1918-19 and in 1923-24 as in 1933-36. In 1937, however, skilled wages advanced at the same rate as common labor. By the end of 1937 the *ENR* 20-cities average for skilled labor, at $1.391, had risen to 102 per cent of its 1929 average, but the average for the year, $1.321, reached only 97 per cent of the 1929 level. This is a rise of 30 per cent over the 1932 average.

ENR's 20-cities common labor average, $0.678, at the close of 1937 stood at 124 per cent of 1929, while its average for the year, $0.645, is 118 per cent of 1929. This is a gain of 51 per cent over the 1932 average.

The rise in labor costs, measured by *ENR*'s 20-cities average, is due not so much to the increase of top scale rates as to the raising of bottom scale rates. In most centers where a differential formerly was reported between non-union and union rates, the gap closed up until the top rate prevailed.

Price Changes—Structural steel shapes at Pittsburgh averaged $2.21 per cwt. for 1937, 115 per cent of the 1929 and 142 per cent of the 1932 average. Two prices increases were made in the first half of 1937, and the top, $2.25, rate prevailed throughout the second half. The Pittsburgh price for structural steel shapes ended 1937 at 19 per cent above December, 1936.

Cement, delivered in New York, averaged $2.47 per bbl., 111 per cent of its 1929 and 153 per cent of its 1932 level. The trend for *ENR*'s 20-cities average of cement prices was slightly down during 1937 until December, when freight rates turned the curve up a little; it ended the year 2 per cent below December, 1936.

Yellow pine, 3 x 12, at $61.50 in New York, is 95 per cent of its 1929 and 154 per cent of its 1932 level. Yellow pine is the only lumber for which long time-price series exist. It is becoming increasingly unsatisfactory, however, as an index of lumber prices. *Engineering News-Record*, accordingly, has started for both Southern pine and Douglas fir, 2 x 4, a 20-cities average series which promises to be more representative of the current lumber market. For 1937 both fir and southern pine showed a price drop in the second half, similar to the pattern established by yellow pine and reported on the accompanying chart for the 18 month period.

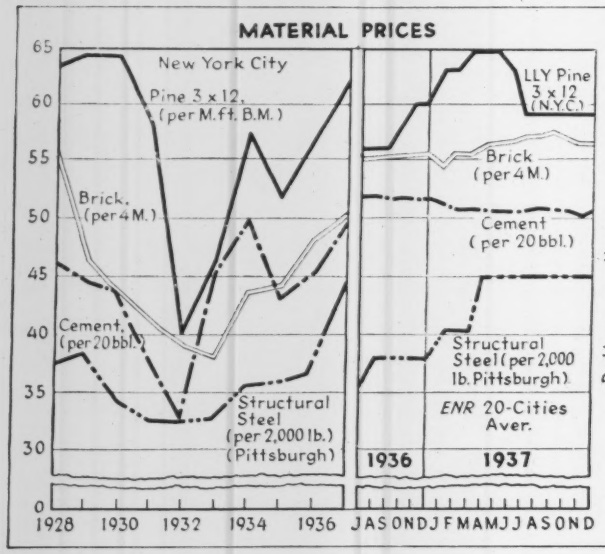


Fig. 1 Materials price trends are mixed—steel climbed and held, lumber and brick dropped last quarter.

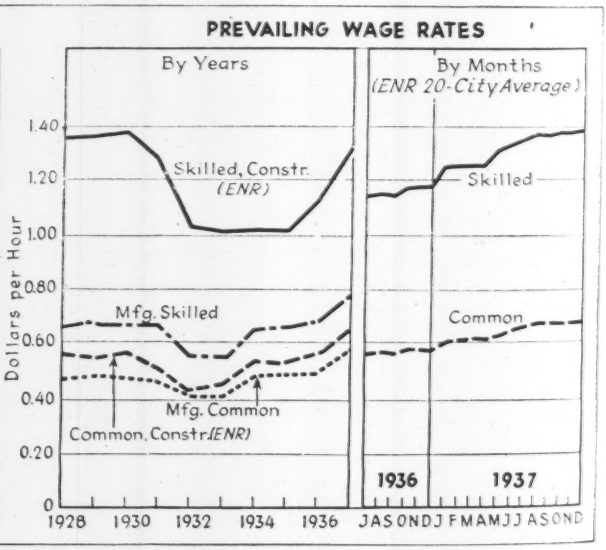


Fig. 2. Wage rates continued their advance through third quarter 1937 then leveled off.

Brick (New York) during 1937 was priced at 107 per cent of its 1929 and 133 per cent of its 1933 average. Brick's depression low lagged a year behind most materials. The *ENR* 20-cities average common brick price climbed moderately through the first 9 months of 1937, but turned downward in the last quarter, ending the year 1 per cent above the preceding year.

Reinforcing steel closed 1937 at 9 per cent above 1936; sand, 4 per cent; 2 x 4 fir, 8 per cent; 2 x 4 pine, 3 per cent; ready-mixed concrete, 4 per cent; structural clay tile, 3 x 12 x 12-in., 0.3 per cent, and paving asphalt 4/10 per cent above, all based on *ENR* 20-cities averages. Price stability or small decreases predominated at the close of the year.

Assuming 1926 as normal year, structural steel and common labor prices have contributed most to 1937 construction costs, but figuring from bottom prices of the depression the rise is due mainly to cement, lumber and common labor.

The effect on construction costs of labor rate and material price variation is measured by *ENR Construction Cost Index*. This time is based on common labor, structural steel shapes, cement, and lumber, weighted. While general construction costs are largely influenced by the common labor trend, building construction is predominantly dependent upon skilled labor. Accordingly, *Engineering News-Record* presents a double index, one series (for general construction) based on the common labor trend and another (for building) based on the skilled labor trend.

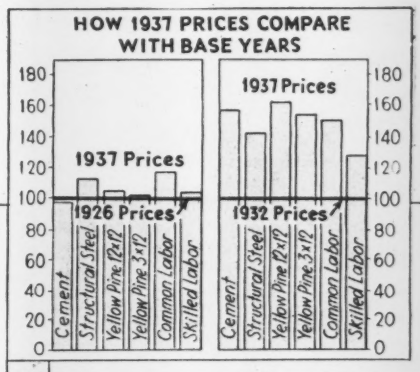
In 1937 the *ENR General Construction Cost Index*, at 236.41, was 20 per cent higher than the *ENR Building Construction Cost Index*, 197.84. Compared with previous years the general index average for 1937 was 114½ per cent of 1936, 114 per cent of 1929 and 150 per cent of 1932. The building cost index was 115 per cent of 1936, 104 per cent of 1929 and 140 per cent of 1932.

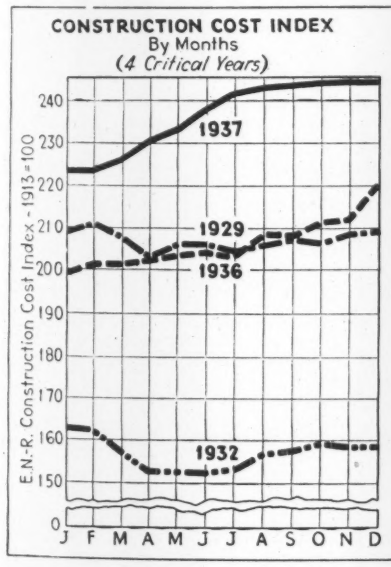
The *Engineering News-Record Cost Index* is a forecasting index, reported at the first of each month. As with all cost indexes its value is relative; its primary function is to call the turns and to indicate the trends. Comparing the above values with other indexes computed by different methods and from different sources of data, Table I results.

Here the American Appraisal building cost index, 30-cities average, shows 1937 costs lagging 11 per cent behind 1929 and only 20 per cent higher than in 1932. The Aberthaw building cost index, computed by a contractor, which applies specifically to New England, shows 1937 costs 5 per cent higher than in 1929 and 18 per cent higher than 1932. Turner Construction Co. building cost index, eastern states, shows 1937 costs 4 per cent higher than 1929 and 41 per cent higher than 1932.

Current Trends—All the index values available from early 1938 reports show decreases from the 1937 peak. It is still too early to identify positively the trend or the stabilizing level, but informed opinion agrees that a flattening out at approximately current levels is the most likely future course. The cost of labor is the key to future trends, not only construction labor but labor in the producing industries responsible for cost of construction materials. It seems unlikely at this writing that labor costs will drop.

	Aver. 1929	Aver. 1932	Aver. 1937	1937 Aver. % of Increase 1929	1937 Aver. % of Increase 1932	Dec. 1937	Feb. 1938
ENR Construction	207	157	236	+14	+50	245	243
ENR Building	191	141	198	+ 4	+40	204	203
Amer. Appraisal (Bldg.)	204	151	181	−11	+20	184	...
Aberthaw (Bldg.)	189	169	199	+ 5	+18	196	...
						Nov.	Jan.
Turner (Bldg.)	185	136	192	+ 4	+41	201	194





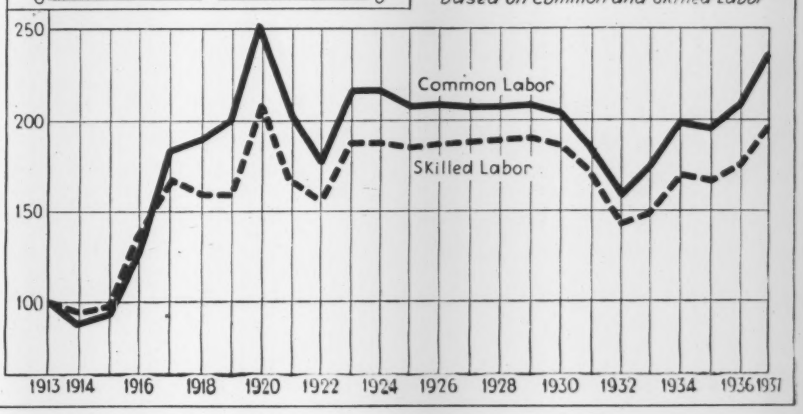


Fig. 3. Construction costs in 1937 increased sharply through July then leveled off.

Fig. 4. (above) Labor and structural steel prices have advanced most compared with 1926.

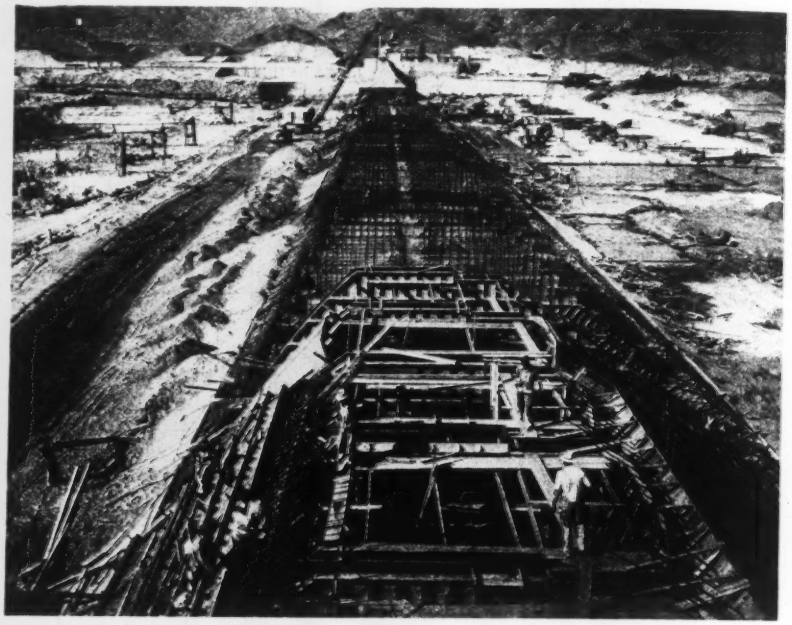
Fig. 5. Construction and building cost indexes are based on common and skilled rates.

Status of Major Projects

Brief reports of progress made during 1937 on large construction projects in the civil engineering field with notes as to work remaining to be done

EVERY YEAR a large amount of civil engineering work is inaugurated and many undertakings are completed. Some are widely reported while others are carried through to completion with little notice beyond the region in which they are situated. Knowledge of these undertakings is of value to men in the construction field. For that reason, the editors of *Engineering News-Record* for several years past have assembled and published annually brief summaries of progress on the larger operations.

Such summaries of progress made during 1937 are given in this and the following pages. They could not have been assembled without the aid of our readers scattered across the country who have provided us with the information on which many of these notes are based.



OVERFLOW WEIR SECTION OF IMPERIAL DAM

MOST concrete was completed in 1937 on Imperial Dam which will divert water into the All-American Canal on the California side of the Colorado River and into the Gila Canal on the Arizona side. Not completed were the Gila Canal desilting basin and headworks; pedestals for the revolving scrapers, influent channel walls and the overflow weir section. The last named structure is of the hollow concrete or "floating type" supported on a compacted fill of selected material with foundation about 20 ft. below normal bed of the Colorado river.

Water Supply

ATLANTA WATER WORKS—Work has started on a $1,250,000 improvement program including a 32 m.g.d. extension to sedimentation and filter units, and the construction of additional supply and distribution piping, and the installation of additional pumping capacity in the raw water station on the Chattahoochee River. The work will be distributed over a 5-year period to avoid borrowing funds.

MONO BASIN—Good progress was made in 1937 on the 11.3-mi. Mono Craters Tunnel which will deliver an average additional 140 sec.-ft. from Mono Basin to the Los Angeles Aqueduct. The tunnel is now expected to be ready for service early in 1939. About 67 per cent of the tunnel has been excavated, and 30 per cent of the walls, arches, and invert has been concreted. Shaft 1 (depth 944 ft.) was completed to grade early in April, 1937 and is concrete lined or gunited throughout. Two earth fill dams remain to be finished.

COLORADO RIVER AQUEDUCT—The 13-mi. San Jacinto tunnel remains the element that will control date of completing the 242-mi. Colorado River aqueduct. At the west end of the tunnel unprecedented water inflows continue to be encountered. Work has continued unabated at both ends of the 16,600-ft. stretch that remained to be driven at the end of 1937. With the aid of Lawrence adit, now down to tunnel grade, four headings will soon be in operation and completion of the tunnel is set for early in 1939. Cajalco dam has been completed; Gene Wash and Copper Basin dams are under construction as are all five of the pumping plants.

PARKER DAM—Successful excavation through unconsolidated water-bearing materials to excellent bedrock at the unprecedented depth of 235 ft. below the Colorado River bed marked the progress made early last year at Parker dam. Later, concrete pouring was carried on continuously; by the end of 1937 almost the entire 280,000 cu. yd. of concrete was in place. Of the 320-ft. height of the dam only 85 ft. is above streambed. Completion of the dam is expected early in the summer of 1938.

DENVER WATER SUPPLY—All construction was completed in 1937 on the Denver's Moffat Tunnel Extension Project. Ralston Creek Dam started to store water in July and the dam was finished in December. The 9-mile pipeline from the dam to the Moffat filter plant was completed in June and likewise the 7-mile line to the city. The 56-m.g.d. filter plant was put into service in August. A 4-mile conduit from Marston Lake filters to South Denver was substantially completed. During the year the 4-mile conduit interconnecting North Denver and Capitol Hill was finished in December.

LITTLE ROCK—The new $3,000,000 mountain water supply project for Little Rock, Ark., will go into operation in April. It consists of a compacted earth

dam, 34 miles of 39-in. gravity pipeline, a reservoir near town and a filter plant. All units have been completed except the filters which will be ready for operation April 1. The reservoir, Lake Winona, will be full in February the pipeline has been tested and is ready for operation.

CINCINNATI FILTERS—A complete rehabilitation of the 30-year old filter plant for Cincinnati will be completed June 1 at a cost of $3,000,000. Reconstruction of the headhouse and 26 old filters and the addition of 14 new filters were included in the project.

DELAWARE AQUEDUCT—On the line of the 85-mi. pressure tunnel, 23 shafts at 18 sites are under construction. Contracts for three sections of pressure tunnels, totaling 20 mi. and including six shafts, have been awarded but not officially signed because of a controversy over prevailing wage rates. In addition to the tunnel, the project for bringing 540-m.g.d. of additional water to New York City will include the construction of three reservoirs; on this work only part of the cut-off trench on the Lackawack Dam is nearing completion. The project cost is estimated at $273,000,000.

BALTIMORE WATER TUNNEL—With 30 per cent of excavation completed since this work was started in April 1937, fast progress is being made on the construction of a 12-ft. diam. pressure tunnel. The tunnel, running from Loch Raven reservoir to the Montebello filter plant, is 6½ miles long and will be concrete lined. It will supplant an existing unlined supply tunnel which will be held in reserve. The total cost is $5,400,000.

BOSTON WATER SUPPLY—Construction of the embankment of the main dam of Quabbin reservoir on the Swift River, last major structure for the additional supply to the metropolitan Boston district, from the Ware and Swift rivers, has progressed steadily. In this 4,000,000-cu.yd. hydraulic fill about 1,500,000 cu.yd. remains to be placed. It will be completed in 1938. The Quabbin dike, which together with the main dam will create the reservoir, is a similar structure containing 2,500,000 cy.yd. of fill; it was completed in December, 1937. Clearing of the 25,000 acres to be flooded by the reservoir will be undertaken during 1938. Two shallow dams and several access roads remain to be built.

CHICAGO WATERWORKS—Work has been started on the Des Plaines Street tunnel, a $1,000,000 project to carry additional water from the Chicago Ave. tunnel system to the new 300 m.g.d. Cermak pumping station. The 1938 budget carries $4,545,000 for filtration and $1,650,000 which will provide for a new deep rock tunnel.

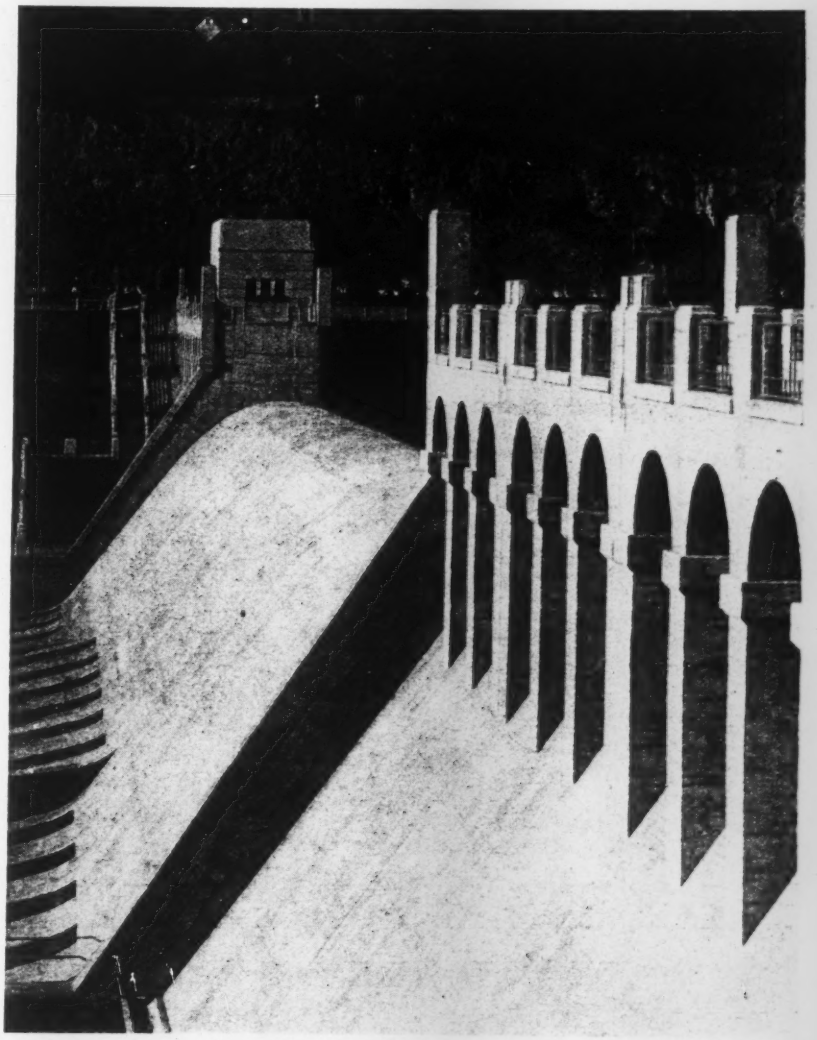
MILWAUKEE FILTER PLANT—The new 200 m.g.d. filter plant for Milwaukee, now 86 per cent completed, will be finished late this year. Contracts aggregating $4,063,000 were awarded last year. Uncompleted contracts total $693,000 and additional ones for $384,000 are still to be let.

O'SHAUGHNESSY DAM—All of the 275,000 cu. yd. of concrete involved in raising O'Shaughnessy dam was in place before the end of the year and the job of grouting will be done within the first two or three months of 1938. The additional height of 85½ ft. thus was available for increasing by 154,000 acre-ft. the water to be stored from this winter's runoff. The dam, originally built to a height of 344½ ft., now is 430 ft. high.

Sewage treatment

WHITE'S POINT SEWER—On October 14, 1937, the 5,000-ft. ocean outfall (5 ft. in diameter) and 6-mi. land tunnel of the Los Angeles County sanitation districts were placed in operation thus marking completion of a project conceived in 1923. Cost of the project was $2,827,000 in addition to which the districts have spent some $12,000,000 for trunk sewers.

NEW YORK CITY—Substantial progress has been made in the program to provide treatment for all sewage in the five boroughs of New York City. The 180 m.g.d. Ward's Island activated sludge plant was placed in operation in October, and construction of the 40 m.g.d. Tallman's Island activated sludge plant has advanced to the point where completion is promised before the end of the year. Bids have been taken on reconstruction of the 50 m.g.d. North Beach screening plant. Plans are in preparation for a 65 m.g.d. activated sludge plant for Jamaica, a 60 m.g.d. acti-



Harry N. Taylor Photo

DOVER DAM IN MUSKINGUM PROJECT

THE last of the fourteen earth dams and the one concrete dam comprising the Muskingum flood control project in southeastern Ohio were completed in 1937. Work remaining to be finished includes completion of the B. & O. R.R. relocation at Bolivar reservoir, relocation of transmission lines at the Bolivar and Dover projects, building of the Magnolia levee and clearing of some of the reservoir sites.

vated sludge plant in Brooklyn, and a 35 m.g.d. extension to the part-time chemical treatment plant at Coney Island. Five chlorination plants were built and operated last summer to treat 100 m.g.d. of sewage flowing to Jamaica Bay.

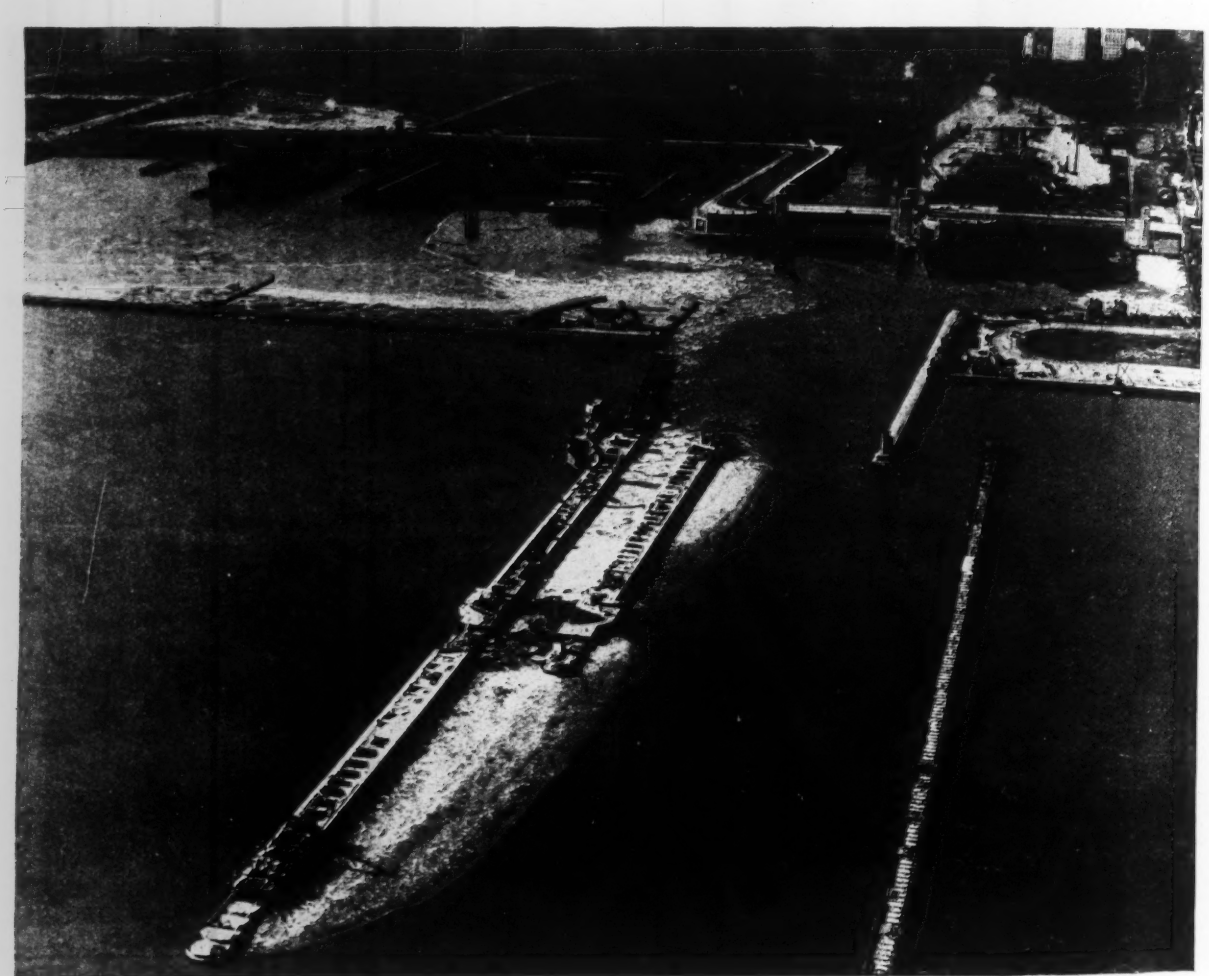
NIAGARA FALLS—The 50 m.g.d. partial treatment plant at Niagara Falls employing fine screens with anthracite coal mat filters, centrifugal sludge dewatering machines and two 80-ton sludge incinerators, is practically completed, and will probably be placed in operation in March. About 5½ miles of intercepting sewers, costing $800,000, were built. The entire project cost $2,050,000.

MEMPHIS SEWERS—Contracts were awarded in January, 1938 for the construction at Memphis of a 14,000-ft. intercepting sewer of 230 sec.-ft. capacity. It is of semi-elliptical shape, 7.33 ft. inside height and 7.0 ft. inside width at spring line. It is designed to collect sewage now discharged at seven points along the Mississippi River and to carry it to the main channel of the river downstream from the city.

TWIN CITIES SEWAGE WORKS—Delayed by bad ground and other obstacles, completion of the $15,500,000 chemical treatment sewage plant and interceptor project of the Minneapolis-Saint Paul Sanitary District is now scheduled for May. The 2,500 ft. of tunnel remaining to be done in 1937 has been reduced to 200 ft. of bad material under high head of water in which progress is very slow. All buildings for the treatment works except the incinerator are complete and the major portion of the equipment installed. All major contracts have been awarded.

COLUMBUS—Construction of a 50 m.g.d. activated sludge plant at Columbus is practically complete. Sewage was turned into the primary settling tanks in November and the plant will be operated as a primary treatment-separate sludge digestion installation until May when the aeration units of the plant will be placed in operation.

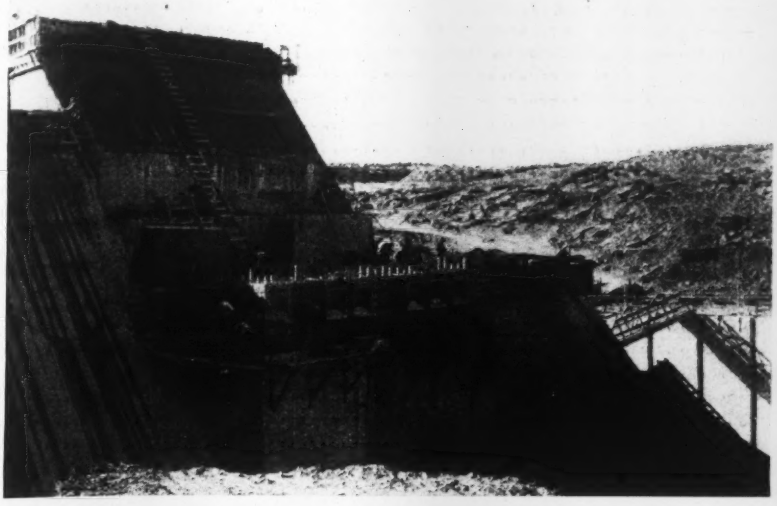
CLEVELAND—Construction is completed and operations are ready to begin at the 123 m.g.d. Easterly activated sludge plant at Cleveland. At the Southerly plant where abbreviated aeration units and sedi-



Chicago Aerial Survey Co.

CHICAGO SANITARY DISTRICT: THE LOCKS PORTION OF CHICAGO RIVER CONTROLLING WORKS

DURING 1937 the Sanitary District of Chicago completed $12,320,000 worth of work which added to the $33,664,000 prior work made nearly $46,000,000 as the expenditures to the end of 1937 on the $60,062,000 PWA program. Of the 48 contracts outstanding during the year, 18 for $6,400,000 were awarded in 1937 and $11,165,000 remains uncompleted. The whole program is 85 per cent under contract and final completion is scheduled for 1938 when 97 per cent of the sewage of the district will be treated. Utilizing savings made in construction, plus profits of investing PWA funds pending use, has made possible 10 additional miles of intercepters and the Racine Ave. pumping station, one of the largest sewage stations in the world. During the year additional final settling tanks were completed for the North Side plant. The 400-m.g.d. West-Southwest plant is 78 per cent under contract and 53 per cent complete. The locks portion, shown above, of the Chicago River controlling works is 85 per cent complete. The new outer drive bridge is also shown.



CONCHAS DAM RISES IN NEW MEXICO

THE principal mass concrete portion of the $12,500,000 Conchas Dam project, which is located on the South Canadian River in New Mexico, is a concrete gravity type dam 235 ft. high on which work, now 36 per cent complete, was commenced in the fall of 1936. More than 210,000 cu. yds. of the 650,000 cu. yd. of concrete included in the contract has been placed. Foundation work within the first cofferdam has been completed and work within the second cofferdam is well under way. The 30-ft. north dikes were completed Aug. 19. The south dike, a rolled earth-fill structure 6,400 ft. long with a maximum height of 98 ft. and involving 2,600,000 cu. yd. of earth and rock fill is 10 per cent complete. As a whole the project is 40 per cent complete. Completion is scheduled for the summer of 1939.

mentation tanks are being installed between existing Imhoff tanks and trickling filters, and magnetic filters have replaced final settling tanks, work is nearing completion; vacuum filters and four 100-ton incinerators have also been installed for handling digested sludge from both the Easterly and Southerly treatment plants.

RARITAN VALLEY CLEANUP — Fourteen projects for the reduction of pollution in New Jersey's largest river are now under construction or completion. This $4,000,000 program will provide treatment facilities to care for 30 m.g.d. of sewage; the individual plants, ranging in size from 0.6 to 10 m.g.d., employ processes varying from plain sedimentation to complete treatment.

ATLANTA—A $6,000,000 improvement program involving 60 miles of sewers and the construction of six treatment plants is nearing completion at Atlanta. The sewers are 60 per cent completed and the status of the plants is as follows: Utoy Creek, 3 m.g.d. primary treatment, and South River, 6 m.g.d. complete treatment, were placed in operation last fall; Intrenchment Creek, 14 m.g.d. complete treatment, is under test operation; Clayton, 42 m.g.d. primary treatment, will be finished in March. Two plants have not yet been started.

BUFFALO—Two years of work have brought the $13,500,000 project for sewers and treatment works at Buffalo to about 75 per cent completion, and operations are scheduled to start in July. The storm relief and intercepting sewer construction is costing $9,000,000. The 150 m.g.d. treatment plant (570 m.g.d. with storm treatment) provides sedimentation and chlorination; sludge will be digested, dewatered, and incinerated.

DENVER SEWAGE DISPOSAL—The $1,500,000, 54-m.g.d. sewage disposal plant for Denver, Colo., was put into operation in November. Chemical precipitation and effluent filtration, sludge digestion and gas utilization are provided, the degree of treatment depending on the flow in the Platte River. This flow is to be augmented by the transmountain Williams Fork diversion, the tunnel for which is under active construction.

DETROIT SEWAGE DISPOSAL—One of the largest disposal projects in the world, designed to handle 420 m.g.d. from a tributary population of 2,400,000, is now more than half completed. Costing $22,600,000, the project includes 10 miles of intercepting sewers ranging from 9 to 16 ft. in diameter, and a treatment plant affording sedimentation and chlorination; sludge will be dewatered and incinerated.

Flood control

RIO GRANDE CANALIZATION—This project, consisting of two features, the American Dam and Canal near El Paso, Tex. and the Channel Canalization of the Rio Grande for 100 miles from the Caballo Dam in New Mexico to the American Dam, is being continued by the U. S. Section of the International Boundary Commission under an additional appropriation of $900,000. The American Dam and Canal, comprising a concrete diversion dam of the radial-gate type across the Rio Grande and a 2-mile concrete-lined canal, is 70 per cent completed. Right of way and construction surveys are now in

WILLIAMSBURG HOUSES COMPLETED IN 1937

AERIAL photograph of this great housing project in Brooklyn Borough, New York. Replacing 12 blocks of slum area, it cost $13,457,000, and will house 1,622 families. The project will be operated by the New York City Housing Authority.

progress on the channel canalization feature. The works are designed to furnish control of the irrigation waters from the Elephant Butte Dam released for American lands of the El Paso Valley and for delivery to Mexico under the provisions of the treaty of 1906.

LOWER RIO GRANDE—The international flood control work located in the Rio Grande delta area was continued by the United States and Mexico during 1937. The United States portion, when completed, will include 120 miles of levee along the Rio Grande, 180 miles of floodway channels, 200 miles of floodway levees and numerous incidental structures. A Congressional appropriation of $1,250,000 was made available for continuance of this work. The U. S. Section is now engaged in channel improvement along the North Floodway in Hidalgo County, Texas. In Mexico the work consists of the construction of river and floodway levees.

SAN GABRIEL DAM NO. 1—With placement of material completed last July, San Gabriel Dam No. 1 of the Los Angeles County Flood Control District now contains 10,572,252 cu. yd. of rolled rock and earth fill. Outlet works were completed in December. Construction of the spillway was begun in June and is now 85 per cent completed. Completion of the project as a whole is expected in June 1938.

ORANGE COUNTY—In July, 1937, voters of Orange County, Calif., approved a bond election which made possible an extended construction program that has been under study for several years by the Orange County Flood Control district. Surveys and plans have been completed for eight earth fill dams to store flood waters and work is to be carried on under direction of the U. S. Engineer Corps. Of the total estimated cost of $15,248,000 the federal allotment is for $12,748,000 and the remaining $2,500,000 is authorized in the county bond issue. Work on the first and largest of the dams is expected to be under way this year; the entire construction program is to be completed in about three years.

BUCHANAN AND INKS DAMS—These two structures completed last year are part of a series of dams being constructed on a force account basis by the Lower Colorado River Authority. The Buchanan multiple-arch dam (11,000 ft. long and 150 ft. high) was completed in July and the power house in which two 17,300-hp. turbines are being installed will be completed in March. The Inks gravity dam 3 miles downstream was also completed in July. One 15,750-hp. turbine will be installed in the power house now under construction.

CABALLO DAM—Designed for flood control and storage of water from the proposed power plant at Elephant Butte Dam for irrigation use, the $2,500,000 Caballo Dam in New Mexico is a compacted earth structure containing 1,300,000 cu. yd. of fill and 20,000 cu. yd. of concrete. A 13½-ft. circular tunnel is 550 ft. long. The 33,000 sec.-ft. spillway is completed except for two 21x50 ft. radial gates. Excavation in stripping, tunnel, spillway, arroyo diversion canal totals 1,138,000 cu. yd. Completion is scheduled for Aug. 15.

GRAND RIVER PROJECT—A federal allocation of $20,000,000 to the Grand River Dam Authority in Oklahoma provides for flood control, a 60,000-kw. hydroelectric development and creation of a recreational area around the 46,500-acre lake. Plans call for a concrete multiple-arch dam, 6,000-ft. long, and 142 ft. high, storing 1,680,000 acre-ft. of water. Power storage of 1,000,000 acre-ft. with a 20-ft. drawdown and storage for the record flood of 220,000 sec-ft., are provided for. Bids for foundation drillings and spillway excavation were asked in January.

WINOOSKI RIVER—All work on the Winooski River flood-control project in Vermont was completed in 1937 except for minor items, including the installation of gates and valves at Waterbury Dam.

TYGART DAM—The last concrete was placed in Tygart Dam, a flood control project on the Tygart River near Grafton, W. Va., in September and the dam was practically completed by the end of the year. The total cost is put at $18,300,000.

SUSQUEHANNA RIVER — Preliminary construction on a flood control project including channel improvements on the upper Susquehanna River and its tributaries and flood detention reservoirs was begun in 1937, chiefly with CCC men. The total estimated cost is $33,000,000. Early in 1938 construction of dams at Ark-

AN INTERNATIONAL BOUNDARY IS BROUGHT UNDER CONTROL

DESIGNED to remove flood hazard and stabilize the river boundary between the United States and Mexico in the El Paso-Juarez Valley the Rio Grande Rectification Project was continued during 1937 by the International Boundary Commission. An appropriation of $875,000 was made for the current fiscal year of the works being built by the United States. On Jan. 1, 150 miles of levee and 75 miles of river channel had been constructed, involving 13,700,000 cu. yd. of earthwork, the project being 85 per cent complete. The river length between El Paso and Quitman Canyon will be changed from 155 to 88 miles.

port and Whitney Point was authorized. Local channel protection work at Hornell, Painted Post, Lisle, Oxford and Avoca was well along toward completion at the end of the year.

SARDIS DAM—Construction of Sardis Dam on the Little Tallahatchie River in Mississippi, a flood control project, was begun in June, 1937. The dam is to be of hydraulic fill construction, about 2½ miles long and 100 ft. high. Active placing of the fill is to begin this year and it is expected to be completed in 1940. The cost, including the land for the large reservoir, will be $10,400,000.

Power development

SKAGIT POWER PROJECT—During 1937 contract was let for the first unit of Ruby Dam on the Skagit River, ultimately to be 640 ft. high, of gravity type, arched in plan. The first unit comprises an arch dam 250 ft. high to be completed June 30, 1939. This first unit will be incorporated later in the high gravity dam.

BONNEVILLE DAM—During 1937 expenditures on the Bonneville project were $10,000,000 and included removal of the north (Wash.) cofferdam, completion of diversion or spillway dam superstructure and erection of spillway gates (5,100 tons of steel); completion of power house and installation of the two 66,000-hp. generating units included in present contract. Navigation locks were completed and were to be ready for service early in January 1938. All fishway structures are complete and operating equipment is being installed.

Irrigation and power

BOULDER POWER PLANT—In June contracts were awarded for two additional 82,500 kva. generators and 115,000-hp. turbines for the Boulder Dam power plant. This will bring the installed capacity to 746,000 hp.

SUTHERLAND PROJECT—The Sutherland project of the Platte Valley Public Power and Irrigation District in Nebraska was practically completed according to the original plans in 1937 but it has not been put into operation. Additional work is needed to repair damage to the system resulting from failure of the concrete siphon under the South Platte River and to improve the operating characteristics of other parts of the system. Since the first of the year $1,061,000 has been allotted by the PWA, bringing the total cost to about $12,000,000.

TRI-COUNTY PROJECTS — Contract for the outlet and spillway works and for steel sheet piling for Kingsley (Keystone) Dam of the Central Nebraska Public Power and Irrigation District was let in June, 1937. Work is about 80 per cent complete. The main irrigation canal structures are practically complete as is about half the work on the lateral ditches for the western half of the project. Plans are ready for the calling of bids for the major work on Kingsley Dam, supply canal and power plant and on the balance of the irrigation channels.

MARSHALL FORD DAM

THE dam contract of the Marshall Ford power and flood control project in Austin, Texas, was awarded in December, 1936. Work was begun in January, 1937. Included are 13 miles of standard-gage railway and an all-weather highway to the dam, also a bridge over the river below the dam site. About 30 per cent of the work on the dam has been completed.

Land reclamation

ALL-AMERICAN CANAL—By the end of 1937 excavation work was practically completed on the All-American Canal except for a short section at Pilot Knob and plugs to protect structures. Twelve construction contracts were under way during the year on building compacted lining, wash overchutes, turnouts, drainage inlets, wasteways, railroad and highway bridges, siphons, flumes, river crossings and power drops. Four more contracts to be let in 1938 will bring under construction all remaining structures on the 80-mi. length of the main canal.

CENTRAL VALLEY PROJECT—Preliminary studies on the Central Valley project were completed in 1937 and sites were selected from several alternatives for Shasta and Friant dams; location surveys were made on more than 80 mi. of main canals and 50 mi. of proposed railroad line. Construction contracts awarded totaled some $600,000 including the first 4 mi. of the Contra Costa canal. Plans were announced for speeding the building of Shasta dam some 2 yr. by use of a bypass tunnel for the railroad under the west abutment thus permitting simultaneous construction of the dam and the 30 mi. of relocated railroad. Call for bids on the railroad bypass tunnel and on another 8-mi. section of the Contra Costa canal were being prepared at the end of the year.

GILA PROJECT—Construction on the Gila project was well under way in 1937 with excavation going on along 20 mi. of the 2,000-sec.-ft. main Gila Canal. Included in the work was the driving of two tunnels, 1,790 and 4,110 ft. long on which concrete lining will start early in 1938. In December a call for bids was issued on the Gila River siphon crossing, a reinforced concrete barrel 19.5 ft. in diameter and 4,250 ft. long.

SALT RIVER PROJECT—Work on the Salt River project included construction of the Bartlett Dam, reconstruction and completion of spillways at Roosevelt, Horse Mesa, Mormon Flat and Stewart Mountain dams, and rehabilitation of the Roosevelt power canal and diversion dam. Bartlett Dam, a 270-ft. concrete multiple-arch structure, highest of its type in the world, was about one-third completed at the end of the year. In January a contract was awarded for completion of the spillway at Mormon Flat Dam. The work in progress will cost about $7,000,000.

UNCOMPAHGRE PROJECT — Taylor Park Dam, on the Taylor River, in Colorado, which will store water to provide a late summer supplemental supply for lands of the Uncompahgre project was completed in December at a cost of $1,500,000.

BOISE-PAYETTE PROJECT—Two additional contracts for construction work on the main canal were awarded in September, one for 5 miles of earthwork and structures and another for 6 miles of earthwork, canal lining and structures. This makes a total of 25 miles either completed or under construction. About 47,000 acres are included in this division and the canal system will cost $6,678,300. Diversion is at the Black Canyon Dam on the Payette River, completed in 1934 at a cost of $1,500,000.

UTAH PROJECTS — The Bureau of Reclamation completed the Ogden River project in 1937, the second to be completed of five Utah projects. The cost of the Ogden River project was $4,200,000. Its principal feature is the Pine View Dam on the Ogden River, a rolled-earth embankment with a rock fill on the downstream slope.

Moon Lake Dam on West Fork of Lake Fork River was nearing completion at the end of the year. Other work in progress during the year was the construction of the Midview Dam and dike and some canal work. In September a contract was awarded for construction of the Spring City tunnel on the Sanpete project, about 5,000 ft. in length, which will divert from

Cottonwood Creek to supplement the water supply of lands near Spring City, Utah. On Dec. 23 bids were invited for construction of the Deer Creek Dam, a 155-ft. earth-fill to store 150,000 acre-ft. This is the first construction job on the Provo River project.

YAKIMA-ROZA PROJECT—Four contracts for earthwork, bench flume, concrete lining and structures covering 16 miles of the Yakima Ridge Canal were awarded during the year. This canal will head at the Roza diversion dam on the Yakima River about three miles north of Pomona, Wash., and will extent southeasterly a distance of 110 miles to provide water for the irrigation of 72,000 acres lying in a narrow strip along the river, from 1 to 3 miles in width. A power plant of 16,000-hp. capacity will be located at the end of the 12 mile section. Of the 110 miles of canal 23½ miles are tunnels, flumes and lined sections. The estimated cost of the Roza division, including its proportionate part of the cost of the storage system, is $18,085,000.

KENDRICK PROJECT—The principal features of the Kendrick project (formerly Casper-Alcova) in Wyoming are the Seminoe Dam and power plant, Alcova diversion dam and the Casper Canal. Alcova dam is 96 per cent completed. It is a rock and earth embankment on the North Platte River near Alcova, 180 ft. in height, 900 ft. long. Seminoe Dam was 50 per cent completed at the end of the year. It is a concrete-arch structure 260 ft. high. Two 15,000-hp. units are being installed in the plant and bids for a third unit were invited on Dec. 30. Excellent progress has been made on the 62-mile Casper Canal. There are 35,000 acres in the first unit and the cost of construction is $20,000,000.

SHOSHONE-HEART MOUNTAIN—There are 42,000 acres in the Heart Mountain division of the Shoshone project, Wyoming, and the estimated cost of construction is $6,500,000. In 1937 work was continued on the Shoshone Canyon Conduit, a 3-mile tunnel heading at the Shoshone Dam. This is a common feature of both the Heart Mountain and the Oregon Basin divisions. Two contracts for earthwork, canal lining and structures on 23 miles of the 28-Heart Mountain Canal were awarded during the year.

ALAMOGORDO DAM—The Alamogordo Dam on the Pecos River near Ft. Sumner, New Mexico, was completed in December at a total cost of $1,833,500. It is a combination rolled-earth embankment and rock-fill structure, with a maximum height of 142 ft. and a crest length of about 1,550 ft. The stored water will be used to supplement the water supply of the Carlsbad project.

OWYHEE PROJECT—Work of the Owyhee Project in Oregon-Idaho during the year comprised the building of laterals and structures on the Dead Ox Flat and Succor Creek divisions, and the construction of pumping plants. The total estimated cost of the project now nearing completion is $18,000,000 and the irrigable area is 117,000 acres.

Waterways

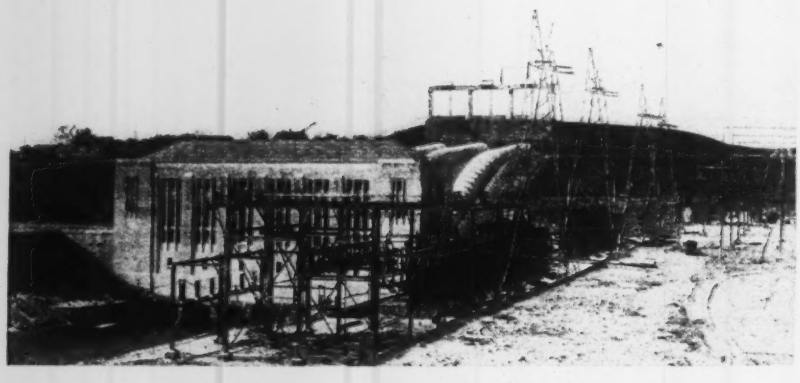
TENNESSEE RIVER—The Tennessee Valley Authority now has under construction or detailed investigation five dams. The Gilbertsville project has been authorized but no appropriations have been obtained. Pickwick Landing Dam, below Wilson Dam, is entering its final construction phase. The navigation lock is in use and the first unit should be ready to generate power by July, 1938. Guntersville Dam, the next above Wheeler Dam, is well under way. The lock has been completed and is in temporary operation. The north embankment is completed and the south embankment is about half completed. Most of the spillway section has been concreted, and at the present time the cofferdam is being constructed for the powerhouse area. Chickamauga Dam, immediately above Chattanooga, was started early in 1936. The lock is completed and in temporary operation. About 85 per cent of the foundation preparation for the north embankment is complete and about 50 per cent of the embankment has been placed, while about a third of the length of the south embankment foundation preparation has been completed and slightly less than a third of the backfill and embankment placed. All but one-sixth of the spillway section is included in the second construction stage and is practically complete at the present time. The cofferdam for stage 3 will be started in the spring of 1938, and concreting in the intake and powerhouse area is expected to begin in the summer. Hiwassee Dam, on the Hiwassee River, is still in the preliminary stages. Much of the foundation excavation has been completed, and most of the construction plant is in place. Concreting is expected to start in the late spring of this year.

CHESAPEAKE CANAL—Conversion of the Chesapeake and Delaware Canal into a sea-level waterway with a minimum width of 250 ft. and a depth of 27 ft. at mean low water is about 90 per cent completed. The initial dredging to 27 ft. has been finished; shoal removal is now in progress in the eastern and western entrances. The work remaining to be done consists of extension of the present jetties at the Delaware River end, installation of mooring dolphins, bridge fenders and other work of minor character. It is estimated that the canal will be completed about March 1, 1938. The cost of this work will be about $14,000,000.

CAPE COD CANAL—The project for enlarging the Cape Cod Canal in the land cut from an original width of 100 ft. and depth of 25 ft. at mean low water to a width of 540 ft. and depth of 32 ft. at mean low water is about 67 per cent complete. The canal is at present 315 ft. wide in the land cut, except about 2 miles of its 7.7 mile length which is 205 ft. wide, and the controlling depth at present in this section, while dredging operations are in progress, is 21 ft. at mean low water. The straight approach channel in Buzzards Bay to the west end of the canal has been completed to a width of 500 ft. and 32 ft. at mean low water.

BARGE CANAL DEEPENING—Deepening of the New York State barge canal between Lake Ontario and the Hudson River to 14 ft. and increasing the overhead clearances to 20 ft., begun in 1936, was about 22 per cent complete at the end of 1937. The estimated cost is $27,000,000.

FORT PECK DAM—Dredging operations at Fort Peck Dam on the Missouri River



COLUMBUS POWER HOUSE: NOTE INTAKE PENSTOCKS

THE Columbus-Genoa project of Loup River District of Nebraska is nearing completion. The 41 miles of canal, dams, desilting basin and regulating reservoirs have been completed and construction work on the two power stations has advanced to the stage where the turbines are under test. Work on the transmission line and substations is about 80 per cent complete.

in Montana put 32,000,000 cu.yd. of fill into the earth dam on the 1937 dredging season, a record for the three years of construction of the project. At the close of the season the fill contained 82,000,000 cu.yd., about 80 per cent of its ultimate volume. The 1937 season also saw the diversion of the river through the four completed tunnels and the closure of the center section of the dam. The spillway was practically completed except for some work remaining on the deep cutoff walls at the lower end of the paved section. Government forces opened up a quarry at Snake Butte, 140 miles from the dam, and started production and shipping of heavy riprap for the upstream face of the dam.

Bridge construction

GOLDEN GATE BRIDGE—Elaborate ceremonies in May, 1937, marked completion of the Golden Gate Bridge and the opening of the 4,200-ft. span to traffic.

BAY BRIDGE—Work is well under way on the terminal building in San Francisco for the San Francisco-Oakland Bay Bridge and on track signals and interlocking systems on the bridge itself. Interurban train service now is expected to start about January 1, 1939.

OUTER DRIVE BRIDGE—The $11,500,000 Chicago Outer Drive Bridge project, which includes a 220-ft. double leaf bascule over the river, one of the largest of its kind in the world, the Ogden Slip single-leaf bascule bridge, north and south viaduct were completed in the fall by Chicago Park District. Extensive extensions and reconstruction of the driveways to the north and south costing $1,675,600 were also completed.

CHICAGO BRIDGES—Three bridges on three important thoroughfares in Chicago were practically completed last year. The $1,330,000 Torrence Ave. vertical lift bridge with 276-ft. vertical lift truss was opened early this year. The South Ashland Ave. 192-ft. bascule costing an equal amount was opened in January. The 103rd St. 2,900-ft. viaduct costing $670,000, which spans the tracks of C. & W.I., the Belt Line and the Nickel Plate railways, was opened to traffic in January.

BATON ROUGE BRIDGE—Construction of combined highway and railway bridge over the Mississippi at Baton Rouge was begun in 1937. At the end of the year two of the five deep piers for the main spans were under construction, and work on the east approach trestle was in progress. Steel erection on the continuous trusses over the river made up of two 858-ft. cantilevers, one 650-ft. center anchor span and two 490-ft. shore anchors, will begin next summer. Total cost is put at $10,000,000.

PORT HURON BRIDGE—This international crossing of the St. Claire River in Michigan progressed to the steel erection stage by the end of the year. Consisting of a cantilever bridge with a main span of 871 ft. and 327 ft. anchor arms and long plate girder approaches, the project is scheduled to be completed in Sept. 1938.

THOUSAND ISLANDS BRIDGE WILL CONNECT U. S. WITH CANADA

THIS INTERNATIONAL project consisting of a series of bridges and connecting highways is about 9 mi. long and contains two suspension bridges of 800 and 750 ft. span respectively, a 350-ft. plate girder arch and a 600-ft. continuous truss of two spans. Foundation work is complete, most of the viaduct steel is up, the continuous truss is erected and the suspension bridge towers for the American spans are finished. The project is scheduled to be opened in August, 1938.

MIDDLETOWN, CONN. BRIDGE — Erection of the two 600-ft. tied steel arches that comprise the Connecticut River crossing of this 3,240-ft. bridge project was completed in November. The approaches had been erected previously.

BRONX-WHITESTONE BRIDGE — Involving a 2,300-ft. span suspension bridge across the East River entrance to Long Island Sound at New York as well as 5 miles of express highway connections, the Bronx-Whitestone Bridge project is geared to one of the fastest construction schedules on record. The first contract was signed June 8, 1937. The Bronx anchorage is now complete while the main piers and the Queens anchorage are about 50 per cent finished. Tower fabrication is about half complete, and grading on connections is well along. The project is to be ready for the New York World's Fair.

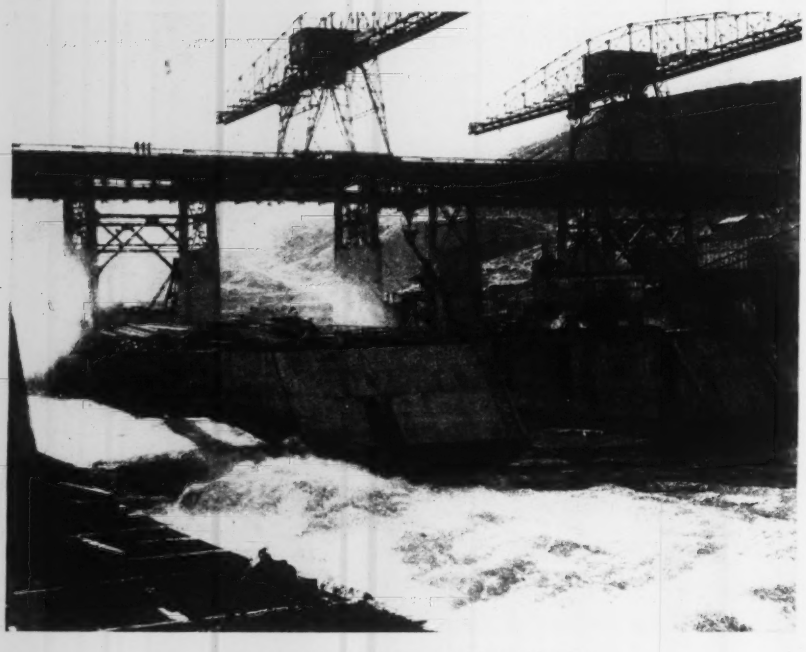
VANCOUVER BRIDGE — Foundation construction on the First Narrows Bridge neared completion at the end of the year and plans were being made to start main span steel erection. North approach steel erection was begun in November. The project involves a 1,550-ft. span suspension bridge, providing 200-ft. shipping clearance, and a 3,000-ft. north approach.

NECHES RIVER BRIDGE — Largest bridge in Texas, this marshland crossing near Port Arthur was brought near completion in December when the closure of the steel of the 680-ft. main span was effected. Some 7,750 ft. long, the superstructure consists of plate girder approaches to a river crossing of cantilever type (main span 680 ft. and anchor arms 374 ft.). The main piers were sunk through artificial sand islands to rock at a 100-ft. depth. Other piers are on piles.

MARINE PARKWAY BRIDGE — Opened to traffic in midsummer, this crossing of Jamaica Bay from Brooklyn to a new city park on Rockaway Peninsula had been erected in record time by floating the 14 spans into place. Containing a 540-ft. lift span, two 540-ft. fixed spans and a series of continuous deck truss spans, the bridge is 3,750 ft. long.

Miscellaneous

EXPRESS HIGHWAY, N. Y.—The express highway along New York City's Hudson River waterfront was opened from its previous terminus at 72nd St. north to the Harlem River (7 mi.) where



GRAND COULEE LOW DAM COMPLETE

AT COULEE DAM near completion of the M.W.A.K. contract, 14 months ahead of schedule, marked the end of 1937. Total expenditure on the project to Jan. 1, 1938, was $58,110,000, and this included placing 4,493,848 cu. yd. of concrete in the dam. Both east and west portions of the dam were brought above low water level and nearly all the east (second) cofferdam was removed. On Dec. 10 two bids were received for the completion of the dam to the ultimate height. The lower bid, for $34,422,240 was made by the Interior Construction Co., a combination of M.W.A.K. interests with several other contractors. This contract has just been let.

it connects with the 4½-mi. Henry Hudson Parkway; the work included burying the New York Central Railroad tracks in a subway from 72nd to 129th Sts. An upper deck is being installed on the Harlem River bridge to take care of the increased traffic. At the south end of the express highway, an elevated extension south from Canal St. is under way.

SAN FRANCISCO EXPOSITION—With 1,400 men at work, the $17,500,000 construction program of the 1939 Golden Gate International Exposition was six weeks ahead of schedule at the end of 1937. The 20,000,000-cu.yd. fill and the 17,760-ft. seawall were completed early in the fall providing a new 400-acre island in San Francisco Bay. Two concrete-and-steel hangars (287x335 ft.) are complete and a $1,000,000 airport terminal building was nearly finished. Other structures, well advanced, include 1,000,000 sq. ft. of exhibit buildings. Steel framework on the 400-ft. tower had reached 200 feet.

NEW YORK WORLD'S FAIR—The New York World's Fair, to be held in 1939, is taking form on the site of the old Flushing Meadows in the borough of Queens. Early in 1937 the grading of the site was completed, which involved the spreading of 6,000,000 cu.yd. of refuse as a shallow fill over most of the site and the dredging of another million yards of material to create two lakes. Foundations for many of the permanent structures were completed, and the main administration building is completed and occupied. Other major buildings that are under construction are: communications, textiles, shelter, foods, medicine and public health, consumers, mining and metallurgy, business administration and the New York City building.

NEW YORK SUBWAYS—Subway construction in New York last year was largely confined to the new Sixth Ave. link in the municipal Independent System. Six contracts, awarded in 1936 and 1937 for more than $36,000,000, are under way. At the end of 1937 work on the various sections were from 13 to 58 per cent complete. Construction was started late in the year on branch of the Queens line extending into the World's Fair grounds.

LINCOLN TUNNEL—The first of two tubes of the Lincoln vehicle tunnel under the Hudson River between New York City and Weehawken, N. J., was opened to traffic last December. Work on the second tube, adjacent to the first, is progressing rapidly. The caisson for the New York ventilating tower has been landed; the shield from the New Jersey shaft is well out into the river; the Manhattan approach tunnel is under way and the New Jersey approach tunnel is well along. Work has been started on the depressed approach road through the cities of Union City and Weehawken, to connect with the tunnel by means of a looping viaduct skirting the face of the Palisades.

QUEENS MIDTOWN TUNNEL—Shafts for the Queens Midtown Tunnel under East River between Manhattan and Long Island City have been completed on both sides of the river, and the approach sections of the tunnel have been started at each end. Shields for both tubes are being erected on both sides of the river, and soft-ground driving will commence early in 1938.

WEST SIDE RAILWAY—Work on the depressed section of the relocation of the New York Central's West Side line on Manhattan Island between the 30th and 60th St. yards was completed during 1937. Construction of the depressed connection to the stockyard is now in progress and will be completed this year. Reconstruction of the 30th St. yard is to be carried on as operating conditions permit. Work of covering the tracks through Riverside Park was completed during 1937.

LOS ANGELES BREAKWATER—The 12,500-ft. Los Angeles-Long Beach detached breakwater, protecting Los Angeles and Long Beach harbors was completed Dec. 29.

LOS ANGELES TERMINAL—"In service before the end of 1938" is the objective in construction on the Los Angeles Union Passenger Terminal in which Southern Pacific, Santa Fe and Union Pacific railroads are combining. The project as a whole was advanced 12.3 per cent during 1937 and was 54.3 per cent complete at the end of the year. Each of the three railroads has started building trackage to connect with the terminal.

GALVESTON CAUSEWAY—All foundation work on the new Galveston Causeway alongside the old one has been completed. All of the 121 piers except the shafts of one of the two bascule piers have been completed, 29 of the 39 main deck units have been poured and the railings placed on 16 units. Abutments and adjacent small spans are done and 90 per cent of the dredged fill. In December the contract for the double-leaf bascule superstructure was awarded. Completion of the structure is scheduled for July.

KEY WEST HIGHWAY—The Overseas Highway is being built on the old Florida East Coast Railway right-of-way between Lower Matecumbe Key and Big Pine Key by the Overseas Road and Toll Bridge District, a political subdivision of the state of Florida. This project is being financed by a Public Works Administration loan of $3,600,000, $640,000 of which was paid to the railroad for their right-of-way including thirteen miles of bridges and thirty-one miles of roadway. At the present time the upper section is open to traffic and the ferry gap is reduced to fourteen miles. The lower section should be ready for traffic in March. Construction started December, 1936.

Water Record of the Year

by JOHN C. HOYT

Hydraulic Engineer, U. S. Geological Survey, Washington, D. C.

Several great floods, including the disastrous inundation of the Ohio Valley in January, marked a year that on the whole was well behaved and brought no recurrence of the preceding year's drought destruction in the Great Plains

THE YEAR 1937 was well-behaved with respect to weather and water conditions. Ample and well-distributed precipitation in most states resulted in generally normal streamflow. There were no outstanding windstorms. The chief abnormal occurrence was the phenomenal Ohio River flood in January.

Nature's erratic ways

That no predictions can be made as to either when or where unusual weather and water conditions may prevail is indicated by a comparison of conditions existing during 1937 with those of previous years. Unprecedented drought visited many sections in 1930 and 1931, but as 1932 approached normal it was generally thought that weather and water conditions would improve in the following years. However, 1933 and 1934 again brought severe drought conditions in large areas. In 1935 conditions again approached normal, but 1936 was characterized by the most severe drought on record in the semiarid states.

Flood visitations overlapped the drought. In the summer of 1935 central New York experienced floods seldom exceeded from comparable areas in any region. In the spring of 1936 most streams in the northeastern United States were in flood, and records of river stages extending to the time of settlement by white men were broken. Again, there were disastrous floods in 1935 in Texas rivers (Colorado, Nueces and others), many of which fell outside the limits of flood-maximum curves, and Texas streams also were unusually high in 1936. Finally, in midwinter 1937 the Ohio and lower Mississippi valleys experienced the worst flood of record; the end of May brought severe cloud-burst floods in the Pecos River basin in New Mexico, and in December northern California experienced record floods.

Rainfall and Water Supply

The following summary of countrywide conditions during 1937 is based on reports from the district engineers of the U. S. Geological Survey.

Precipitation—For the water year of 1937 (Oct. 1, 1936 to Oct. 31, 1937) precipitation was well above normal in most states east of the Mississippi (see map, Fig. 1). Virginia reached 22 per cent above normal. There were deficiencies in all the semiarid states, 28 per cent in Nebraska. During some period of the year in most states there was abnormally large precipitation. Virginia's October rainfall was the greatest on record, 7.54 in.; January rainfall over the Ohio River basin was especially heavy, averaging about 12 in. over the basin above Cairo.

During the crucial growing period, May to August inclusive, precipitation was above normal in the northeastern part of the country, but elsewhere generally below normal, with sharp local deficiencies, as in the area about Topeka, but in no case comparable to the shortages of the recent drought years.

Temperatures—Summer temperature is of significance to water supplies, as it determines transpiration and evaporation. For the country as a whole, 1937 summer temperatures averaged about 2 deg. above normal during May to August, the greatest excess (3.5 deg.) occurring in the

Fig. 1. Rainfall in 1937 was moderately above normal in the eastern half of the country and moderately subnormal in the semiarid states (upper figures, departures in inches; lower figures, departures in percent of normal).

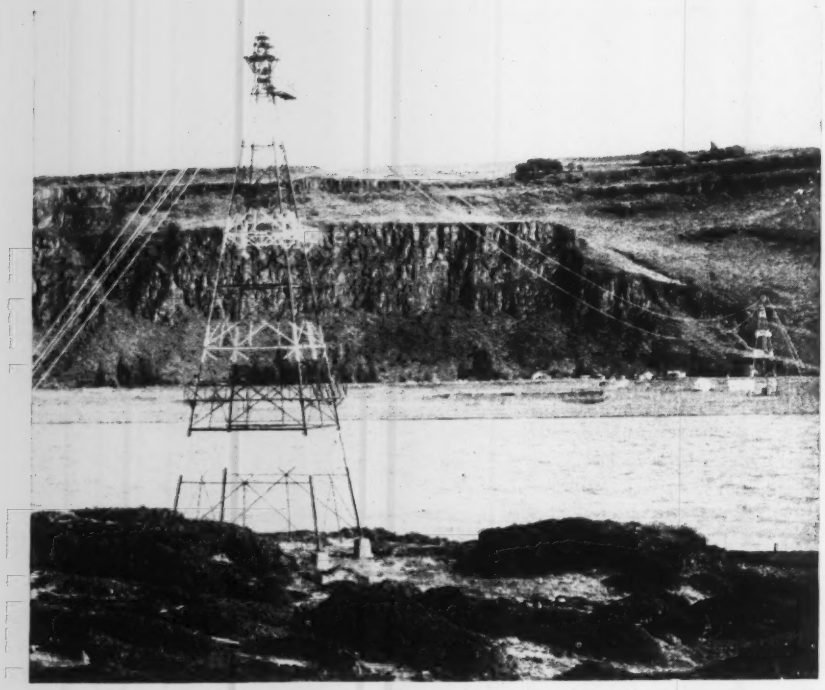


Fig. 2. Long-span cable strung across the Columbia River at The Dalles, on 110-ft. towers, to carry a car for regular gaging of river flow by current meters as an aid in operating Bonneville power plant.

area west of the Mississippi River.

Water supplies—No unusual shortages in water supplies were reported. Adequate facilities are now usually available to meet most deficiencies due to unusual weather, as far as urban and industrial supplies are concerned.

Low water in the upper and middle Mississippi caused some interruptions in navigation during the latter part of the year.

Three severe floods

Three outstanding floods broke previous flood-flow records: January-February on the Ohio and lower Mississippi Rivers, May 28-June 4 on the Pecos, and December in northern California.

In the great Ohio River flood maximum flows were recorded as follows: Huntington, 654,000 sec.-ft.; Louisville, 1,110,000 sec.-ft.; Metropolis, 1,730,000 sec.-ft. (not including 72,000 sec.-ft. through a flood channel at New Columbia, Ill.); Mississippi River at Memphis, 1,930,000 sec.-ft. For several days the Ohio was above flood stage throughout its length.

The total precipitation during the period Dec. 25, 1936, to Jan. 25, 1937, over the Ohio River drainage basin ranged from 6 to 20 in., averaging 12.8 in. over the basin above Cairo, Ill. Although much damage was done, the levees generally held and were kept from overtopping by temporary dikes on top.

It is interesting to note that the Ohio River flood occurred in the year following the unprecedented floods in northeastern streams draining into the Atlantic Ocean from Virginia north and in the Ohio River above Pittsburgh, during which previously recorded high flows were broken. The outstanding features of both the 1936 and 1937 floods were that they covered great areas and were of long duration, resulting in excessively large peak rates and total volumes.

Cloudbursts over wide areas in eastern New Mexico produced intense floods in the Canadian and Pecos River basins during May 27 to June 4. Large damage was done, and Roswell was flooded three times in this period. The Pecos above Roswell was at greatest flood known.

Finally, in December the most severe floods in more than forty years occurred in the Sacramento and San Joaquin River basins in California. Previous maximum discharge apparently was exceeded on the Kings, San Joaquin, Merced and upper Sacramento Rivers. From preliminary computations, it appears that maximum discharge on San Joaquin River at Friant, Calif. was about 75,000 cfs compared with the previous maximum at this point (1907-1936) of 54,000. It is estimated that the peak discharge of the Kings River at Piedra equaled that of the San Joaquin River at Friant. The Sacramento near Red Bluff reached a maximum stage of 36.5 ft., or about 1.3 ft. above prior maximum.

During the past year the U. S. Weather Bureau has inaugurated plans leading to the extension and enlargement of its flood warning service. Engineers are being trained in flood prediction work and are being assigned to various important centers, and arrangements are being made whereby additional precipitation records and related data will be made available. The work is being carried out under the direction of Merrill Bernard, chief of the River and Flood Division of the U. S. Weather Bureau.

Low flows—Due to dry weather and ice the Mississippi River at St. Louis reached a stage of —5.5 ft. (28,000 sec.-ft.) on Dec. 12, 1937. This was 0.9 ft. lower than the previously recorded minimum of —4.6, December 1933 (35,200 sec.-ft.).

Groundwater—In the humid section of the United States, where precipitation during 1937 was normal or somewhat above, lowest ground water was generally higher than the low points of 1930 and 1931.

Improvement of equipment

Progress has been made during the past year in the methods and equipment used for the measurement of large rivers. A measuring cable (Fig. 2) with a clear span of 1,727 ft., supported by towers 110 ft. high, was installed across the Columbia River 20 mi. above The Dalles, Ore., in cooperation with the Corps of Engineers to determine the flow of the Columbia for guidance in operating the Bonneville power plant. Lights protect planes on the river air route.

A new motor-propelled reel and boom that will handle a meter with a 500-lb. streamlined weight is being built for use in measuring the Mississippi River at Vicksburg, Miss., and lighter power booms are being built for 100 lb. of lead.

Speaking for the Contractor

by EDWARD P. PALMER

Senior & Palmer, Inc., New York City

Construction problems and prospects discussed from a practical viewpoint by the new president of the Associated General Contractors

ANY DISCUSSION of current trends in the construction industry which aims to be at all comprehensive must reach beyond the evidence supplied by statistics, and must include some reference to economic and regulatory developments.

From the statistical point of view, the calendar year 1937 when compared with 1936 gives ground for some encouragement. Records of construction activity show that the 1937 volume, the total of public and private, exceeded that of 1936 by a small margin. To stop with this statement, is to give a misleading impression. A statement of the trend during the year is more illuminating as we look to 1938.

Private construction

One year ago, indications pointed to an upward surge in construction volume. These prospects were borne out during the first six months, at least in the field of privately financed construction. However, beginning in late summer there occurred a definite decline in such work.

It is generally known to the trade that private construction almost disappeared during the depth of the depression and, while steady gains have been made from the low point, the volume of such work is still distressingly low. The lay press has consistently neglected to point out this fact when citing high percentage gains over previous years. So it is in comparing private construction volume of 1937 with 1936. Statistics show a 46 per cent gain in 1937 over 1936, yet the 1937 volume was no more than a third of the demonstrated capacity during pre-depression years.

The early 1937 outlook for a substantial upward trend was especially bright in the private construction field. However, to those familiar with private construction financing there was apprehension of the anticipated effect of the 1936 Revenue Act. The Associated General Contractors sought to relieve from the undistributed profits tax such monies as were used for capital improvements, and a bill to accomplish this purpose was introduced. Even at this late date it appears that were this penalty removed much would be accomplished toward reversing the present volume curve for private construction.

The railroads, normally large buyers of construction, find themselves ground between low rates and high operating costs and will do little beyond urgent replacement. The other utilities hesitate to proceed because of recent developments and future uncertainties.

To sum up, there appears little reason to expect any considerable volume of private construction this year.

Public works and PWA

Looking at the field of public works and considering that portion executed by contract we find little gain in 1937. Here also an erroneous public impression exists. Public works have been so publicized in recent years that the layman cannot be criticized for believing that the nation was engaged in its greatest public works program. The truth is that at no time during the depression has the volume of public contract work equalled the volume of pre-depression years in this field.

While the federal government has put more funds into this kind of work during the past few years, subordinate governments have retrenched, some by necessity, many by choice. The chance of using Washington money instead of their own has been alluring. Until those subordinate governments which can finance their own public works reenter the market, there does not appear any way to supply the volume of public works necessary in our national economy except through federal appropriation.

Recognizing this condition, the contractors, through the A.G.C., early in 1937 urged continuation of the PWA program as preferable to an expanded WPA program. While this effort was successful as far as Congress was concerned, it was forestalled later by an executive order terminating the PWA program.

During 1937 some gestures toward a balanced federal budget were made. In nearly all cases it was proposed to accomplish something in this direction by curtailing the regular construction program of the federal government. This culminated in the Presidential request in the special session of Congress for the curtailment of the regular aid highway program. Fortunately, Congress took no action and allotments have gone forward for the fiscal year 1939. Income from federal taxes on highway users far exceeds expenditures for the above program. The present plan of automatic allotment to the states is the only means that will permit adequate advanced planning for highway needs.

Labor troubles multiply

It has been an eventful year in the field of labor relations. Organizations have developed among construction employees in territories and in classes of work not heretofore organized. New and complicated problems have arisen, particularly in the field of highway and heavy construction, to which many believe the craft type

of organization is poorly adapted.

The number of strikes in the industry during the year greatly exceeded the number during 1936. These strikes averaged 38 per month during the first seven months of 1937 compared with an average of 19 per month for the year 1936—a 100-per cent increase. The average lost time per month in 1937 was 59,000 man-days, compared with the 1936 average of 29,000 man-days. Jurisdictional disputes resulting in the closing down of work and other short time strikes might swell the figures greatly.

This evidence prompted the Associated General Contractors at its fall board meeting to adopt a series of labor policies in the attempt to serve its chapters and members. An information exchange was established to act wherever its good offices would be useful in overcoming these frightful losses.

Wages, prices and taxes

Construction wages and material prices remained in the public eye throughout 1937. In order to get a proper perspective of both, it is useful to review these figures for several years past. Assuming the 1913 level as 100, we find that wages reached 232 in 1930, from which they descended to 176 from April through November, 1933. From that point they have risen to a high of 235 in July, 1937. Considering 1937 alone, the figure in January was 210. It advanced to 217 in May, to 234 in June, and reached its present high of 235 in July. The present level is thus slightly above 1930 and 34 per cent above the depression low. Materials increased 12½ per cent above the depression low and decreased 10 per cent from 1934.

While wages and materials constitute the largest part of construction costs, various legislative enactments are constantly increasing other costs. Taxes bear with unusual heaviness on construction. Among these are sales taxes, use taxes, license fees, business privilege taxes and social security taxes, which cover both unemployment and old age insurance. In regard to taxes for unemployment insurance, construction is placed in a peculiar position. Wages paid in this industry are admittedly higher than wages for equivalent employment, to compensate for broken time—in other words, the rate of wages covers unemployment compensation.

However, payroll taxes are levied on the whole wage and thus the industry is paying twice for the same thing. Furthermore, the states will shortly assess taxes for unemployment insurance on the merit and demerit rating. It is foreseen that this practice will penalize the industry for the very obvious reason that the contractor who operates over any considerable area will not be able to show continuity of employment. Most public-works contracts require that workmen be obtained locally. This demand is further reinforced by labor union rules. These limitations, coupled with the fundamental temporary nature of the construction business will have the effect of giving the contractor a demerit rating.

Day labor trends

The most serious development of the recent past has been the trend toward the use of the day labor method. The contractors ask other businessmen, especially those dependent on construction, to ponder it well. While there is, at the present time, no proposal to extend the WPA policy of construction to include the production of materials and machinery, there is every reason to believe that if this policy becomes established another bureaucracy will appear to engage in these activities. All reasons which are given for displacing the contractor can be applied, with equal logic, to the material producer and to the machinery manufacturer.

Aside from the social and political aspects of this question, there remains always the obligation to the taxpayer to provide public works of quality at low cost.

Referring briefly to the question of quality, construction men know that there is scarcely any field of human endeavor in which quality is so varied as in construction. They have found from experience that it is unwise to entrust to the same authority the interpretation of regulations and specifications and the actual building of the works.

Upon this experience the industry has, through the years, devised for itself a *modus operandi* defining the functions of each part—the engineer or architect to design and supervise, the contractor to build.

The failure of public works built under the day labor system is eloquent evidence of what occurs when this historic practice is violated. Those interested in promoting the day labor system argue that such failures will become fewer when their technical services are better organized. Doubtless there will be improvement, but there still remains the important question of cost, and it is upon this point that contractors base their greatest complaint, for the reason that the public is not told what a day labor job costs. Probably no one knows, so replete are such operations with hidden costs. For example, "Workmen's Compensation" on the Norris Dam is handled by "The Federal Employees Compensation Commission" and benefits are paid from a fund provided by a Congressional appropriation.

Another apparent "saving" on day-labor jobs is relief from the payment of social security taxes, but the saving is not real. Men on day labor jobs get old (in action sooner than in years perhaps) and they will get old age pensions, probably from Congressional appropriation — another hidden cost. But for the moment, the relief from social security taxes offers a point for day labor advocates.

If one would be fair in judging the relative cost of day labor and contract construction he must set down as a credit on the cost of a contract, the contractor's contribution to the cost of government through the long list of taxes.

But waiving such credit and hidden costs, estimated from 12 to 15 per cent, still the contractors can compete on cost and have demonstrated that fact in the few tests which judiciously minded public officials have made. They crave and should demand more such tests.

What do construction men want? The writer knows he can speak for the contractors and, he believes, for the great majority of others engaged in the industry. They ask two things: *First*, the removal of barriers to private construction through the establishment of confidence on the part of investors that they may invest in construction with security; *Second*, they want the historic practice of building public works continued because it affords the best means of discharging their obligation to the community—the obligation to provide good public works cheaply.

Surveys of Engineering Fields

Eight authorities in special spheres of engineering activity here present concise analyses and reviews of developments that have taken place during 1937

CIVIL ENGINEERING advance is primarily the sum total of progress in those fields of work in which active demand for improved facilities calls upon specialists to develop new methods, improve materials and build more efficiently. To give a broad perspective of 1937 advance, therefore, leading authorities in the most active branches of construction set forth the year's major accomplishments in the following pages. Their themes are: Structural Engineering, Bridge Construction, Water Supply, Hydraulics, Sewage Treatment, Flood Control, Soil Knowledge in application to foundations and dams, and Research.

Progress in Structural Knowledge

by HENRY D. DEWELL

Consulting Engineer, San Francisco, California

Reinforced concrete promises to have wider use, following results of continued research

A TRUE APPRAISAL of the year's progress in the field of structural engineering must note not only achievements and accomplishments —remarkable structures completed and results of research—but also the trend of structural thinking. The latter indicates the probable line of advance in the early future. As constructive thought is not measured by the calendar, the present review and appraisal of 1937 progress in structures does not adhere strictly to the calendar year.

Development of Concrete

Of the structural materials, reinforced concrete holds the largest promise of increased and wider use in structures, as is evidenced by reports of the results of continuing research along theoretical and experimental lines, both in America and Europe. Indeed, it would seem that European thought and practice are considerably in advance of the work of the conservative American engineer. Of outstanding interest because only recently given much attention here, the accomplishments of the French engineer Freyssinet in the production of high-strength concrete and in the prestressing of the reinforcing steel deserve note. The practical production of concrete with a compressive strength of 14,000 lb. per sq. in. attained in two or three hours, prophecies of concrete with strengths of 17,000 to 21,000 per sq. in. and the advantages claimed for prestressing the steel, betoken large possibilities. Even more advanced is an almost revolutionary method of design of reinforced concrete, the conception of the Russian engineers, Steuerman and Kopciowski, which has been in use in Russia for some years by government order but was published only last year. The method, which throws overboard many of our standardized and conventionalized ideas of the action of reinforced concrete, is in line with work done by Saliger in Germany and Coppee in Belgium.

Showing the trend of research in this field are the investigation of the effect of rust on the bond between reinforcing bars and concrete by the Concrete Reinforcing Steel Institute in cooperation with Lehigh University; Swiss tests indicating that the minute cracks formed in the natural functioning of reinforced concrete members are not dangerous except in unusual exposures; Russian tests on flat slabs; measurement of the steel stresses in large concrete pipes in California; Swedish investigation of the effectiveness of splicing and anchoring of reinforcing bars; continued investigation of the stresses of concrete knee frames and of the plastic flow of concrete.

Some reinforced concrete structures worthy of note, completed during the past year, are a chimney at Selby, Calif., 606 ft. in height and said to be the highest in the world; a California school which utilizes hollow rigid frames of 77-ft. span to support an auditorium roof; the 549-ft. shaft of the San Jacinto Memorial in Texas; two 3,000,000-gal. elevated tanks; a thin-shelled barrel roof having a span of 220 ft. and a shell thickness of only 3½ in.; and the novel design of a Wisconsin building which employs "morning glory" columns—slim, tapering, hollow concrete shafts, topped by shallow flaring circular caps supporting a multidomed flat roof slab.

Structural Steel

Progress in the field of structural steel has been in line with increased confidence in the material; the use

of higher working stresses and wider use of welding, instead of riveting, is noteworthy. It may not be many years before the din of riveting, together with the bedlam of automobile horns and the blare of street advertising radios, will no longer wrack the nerves of the helpless office worker.

In the field of structural experimental research, tests of knee-shaped steel frames have been continued by the American Institute of Steel Construction, a correlation of theory and experiment. During the year the attention of American structural engineers has been called to the important and detailed report of the British Steel Structures Research Committee. This report not only presents results of theoretical analyses and experimental studies of actual building frames of structural steel under both vertical and lateral loading, but also establishes definite design rules which take into account the rigidities of structural members and their connections. British structural practice has been accordingly and profoundly affected and it is probable that American design methods will be correspondingly influenced, although to a lesser extent.

Extended use of welded connections of steel is found in a building at Middletown, Ohio, with a welded steel frame and hollow steel walls filled with rock wool; a building in Meriden, Conn., with sawtooth roof supported on welded rigid steel frames; a building at Linden, N. J., in which welded steel frames support the roof monitors. Other notable steel structures are the 303-ft. roof trusses of an aircraft assembly building in Baltimore and a livestock exposition building at San Francisco in which three-hinged arch-cantilever roof trusses span a width of 300 ft.

Timber and Brick

Timber has its principal structural use in temporary structures. As in the field of concrete, European practice has been in advance of American practice, particularly in the invention and use of ingenious timber connectors. During recent years the importation of these connectors and American improvements made thereon have extended the utility of structural timber. The past year brought out an improved type of metal timber connector, the flush-type shear-plate, which has made possible the successful construction of a number of demountable tall timber oil derricks and their immense timber walking beams, utilizing commercial sizes of planks and timbers.

A specially notable example of timber framing is found in the 204-ft. roof trusses of a new aircraft factory at Seattle. Perhaps the timber framing of the buildings of the Golden Gate Exposition at San Francisco best exemplifies the advance in the art since 1915, when the Panama-Pacific International Exposition exalted timber framing.

Instructive examples of reinforced-concrete brickwork are school buildings in California designed against earthquake, and the ventilation of buildings of the Lincoln Tunnel, New York. Reinforced brickwork will come into wider use when its limitations as well as its advantages are more generally recognized, and when its dependence on intelligent design and competent and honest workmanship is realized.

Advance in Building Control

The year saw the adoption of a new building code in New York, progressive modifications of the Chicago building code, and the completion of the Uniform Building Code of California, representing ten years' work by California chapters and sections of the national societies of engineers, architects and contractors in collaboration with the Pacific Coast Building Officials Conference. Both the New York and California codes permit the use of welding in structures. Both are conservative, as building codes usually are, in that their maximum working stresses are lower than those of the latest specifications of the American Institute of Steel Construction and the American Concrete Institute. The California code is distinctive in that it requires planned resistance to earthquake. Its engineering portions have been in use since 1933 as the text of the Rules and Regulations of the California State Division of Architecture; also, many of its provisions have been incorporated in the text of the Uniform Building Code of the Pacific Coast Building Officials Conference, which is in general use in the Western States.

Distinctly representing progress in structural design is the abandonment of specified moment coefficients, except for flat slabs, in the California code and also in the 1937 Progress Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. However, the California code, and likewise the state's regulations, permit the design of flat-slab structures as indeterminate structural frames. By this method all arbitrary dimensional limitations of slabs, dropped panels, and column capitals are abandoned.

Earthquake Resistance

Advance has been made in seismic research and investigation, and the allied subject of the action of structures in earthquakes. In this field, the purely scientific study of earthquake phenomena is so closely connected with that of the response of the structures to earthquake ground waves that in any review the two cannot logically be separated. During the past year the seismic survey program of the U. S. Coast and Geodetic Survey has been further extended outside California. Unfortunately, decreased funds have curtailed its field work.

Study of the action of structures during earthquakes by means of models subjected to predetermined oscillation simulating earth movement during an earthquake, with accompanying theoretical analyses, has continued under Jacobsen at Stanford University, Martel at the California Institute of Technology, and Ruge at the Massachusetts Institute of Technology, with illuminating results showing definite tendencies, if not definite conclusions.

At Stanford University, the work has been mainly in connection with tall office buildings, utilizing the extensive measurements of periods of California buildings made by the C.&G.S. These studies have clearly brought out that any calculation of building vibrations and any method of design of buildings, considering them as dynamic structures, to resist earthquake are both misleading and worthless if they do not take into account the deflections of shear as well as those of moments. The principal work at the Massachusetts Institute of Technology, under the

sponsorship of the Associated Factory Mutual Fire Insurance Companies, has been the study of elevated steel water tanks. Just issued are "Tentative Specifications for Earthquake Resistant Tanks and Towers." These boldly suggest a new type of construction embodying increased flexibility combined with snubbing by heavy springs.

It is questionable whether the subject of the earthquake action on structures is yet sufficiently understood to warrant the abandonment of the static method of design, except for tall flexible structures.

Bridge Engineering in 1937

by ALBIN L. GEMENY

Senior Structural Engineer, U. S. Bureau of Public Roads, Washington, D. C.

Highway bridge construction dominated the activities of a year marked by increasing use of continuous spans and a trend toward light floor types.

A LARGE majority of the bridges constructed in 1937 were for highway service. The money spent for bridges on state-administered highways alone was about $140,000,000 in 1936, some 23 percent of the total road expenditure of $607,000,000, and the 1937 figure should nearly equal this sum, according to incomplete records.

While in one sense the volume of bridgework constructed represents progress in the solution of highway traffic problems, it does not necessarily measure progress in the art and science of bridge engineering, except insofar as activity in any field of construction is a stimulus to research in that field. Real progress is indicated by the expansion of our knowledge of the materials and theory of structures as well as the development of new materials, designs and methods of construction.

A new record in magnitude of individual bridge projects was reached with the completion of the gigantic Bay and Golden Gate crossings at San Francisco, where within a radius of a few miles more than $120,000,000 was invested in two bridges. A large bridge was completed on the Marine Parkway, New York City, doubledecking of the Henry Hudson arch was begun, and work on the Baton Rouge and Whitestone bridges was started. The Thousand Islands international bridge made progress.

The conditions which justified the vast expenditure at San Francisco are illustrative of similar conditions in many other parts of the country. The present normal increase in highway traffic is largely on main highways between population centers, and, since most of these centers are on bodies of water, traffic growth leads increasingly to demands for large-scale bridge construction. This tendency will probably grow stronger in the future.

Efforts to improve materials

No new bridge materials appeared in practice, but efforts to improve the well known materials were intensified. There was a continuing inclination among engineers toward the use of steel, instead of concrete, for structures where these two materials were competitive. However, research and thought aiming at the improvement of the quality of concrete, coupled with its obvious architectural advantages—which are becoming rapidly more important—seem destined to broaden its use for bridges in future. Improved methods of fabricating timber structures led to an increased use of this material during 1937, but there are no indications of a widespread desire to substitute timber for concrete and steel in permanent structures.

Insistence on esthetic merit in bridges reached its full strength during the past year. Engineers now strive for bridges which please the eye, and they are willing to make considerable sacrifices in economy to attain this end. In fact, it may be said that engineers now generally place appearance second only to structural adequacy. There are even some who believe that architectural considerations should control and that structural features should be made to harmonize with these considerations.

Steel bridge design

In the field of steel bridges multiple simple spans have almost gone into the discard. Continuous beam and girder spans are being generally adopted for intermediate lengths. Rolled beam spans now exceed 100 ft. in length, while girder spans have been built up to 200 ft.

Fig. 1. Continuous bridge with cantilever ends over Western Pacific R.R. near Lake Point, Utah, along eastern shore of Great Salt Lake.

Fig. 2. Southern Pacific R.R. overpass at Oil Junction, Calif., an example of modern multi-span continuous construction.

For long spans continuous trusses or cantilevers are used. There is widespread use of rigid frames, particularly for single spans up to 100 ft. in steel and somewhat less for concrete. Special designs for continuous trusses and girders have appeared which offer the advantages of continuity while providing for temperature effects, which become troublesome in structures of more than three continuous spans. Some thought is being given to hinged piers to provide for temperature movements in multi-span continuous designs, although this type of structure has not yet been used in this country.

Progress in welding as applied to steel bridges has been slow. Its use has been confined to minor connections and repair of old structures. However, real progress has been made in metal preparation for future development of this art, and the attitude of bridge engineers has changed from one of distrust to one of interest in its possibilities. The publication in 1936 of the first specifications for welded bridges by the American Welding Society was a big step forward. Comprehensive experiments are now being planned to answer some of the questions which have raised doubts as to the dependability of the process. We need more information on internal stresses created by the welding process and the fatigue resistance of welded connections, and need to develop simple effective methods of inspection.

While concrete is particularly adaptable to architectural effects it is also subject to defects which may completely spoil these effects. To get concrete of better quality, vibration has come into general use in bridge construction. The internal type of vibrator is almost exclusively used. It is common practice now to line concrete forms with plywood or other such material so as to get smooth surfaces and accurate lines.

No fundamental change in concrete materials or construction has occurred recently in this country. Our efforts to improve this material have consisted in exercising more care in the steps of concrete making.

In Europe, particularly in France, more fundamental solutions for the problems of concrete are being attempted. Efforts are being made to produce a cement which will consume all of the mixing water and expand in setting, thereby making possible a dense, impervious concrete of very high strength. The prevention of shrinkage obviously overcomes one of the most troublesome properties of concrete. French engineers have also produced remarkable concrete by developing practical methods of placing the concrete in pressure for setting.

Light floors

In recent years a number of special types of light-weight bridge floors have been developed, composed of various combinations of steel shapes and concrete. It is now generally concluded that these floors are economical only on long spans where a saving in main truss or girder metal is possible, or on heavy movable bridges in which reduction of dead load is important.

During the past year research on bridge floors was begun as a co-operative project by the Bureau of Public Roads, the Illinois highway department and the University of Illinois. This is the most comprehensive attempt ever made to solve the problems involved in the design of floors of various types under concentrated as well as uniform loads. The progress that has been made to date indicates that this research will result in important additions to our fundamental knowledge of this element of our structures and will have application to all types of structures.

In conclusion it may be said that never before have bridge engineers been so elert to new developments in their field. While retaining in general the conservatism necessary for safety of such important structures as bridges, they are anxious to make full use of new materials and processes which have merit.

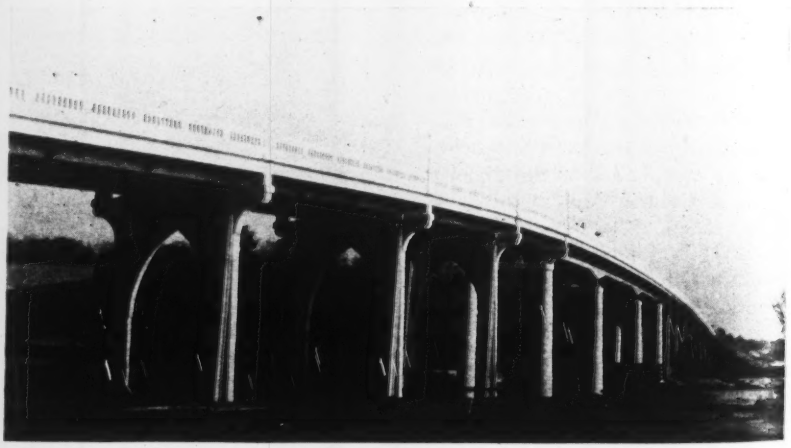


Fig. 3. Architectural concrete piers of a rolled-beam bridge reflect the current trend toward esthetic development.

Water Supply and Treatment

by Loran D. Gayton
City Engineer, Chicago

Progress was made by increasing the efficiency and reliability of equipment and by closer perfection of water-treatment processes.

It has been said that in the field of water supply, progress is always evolutionary, never revolutionary. This statement holds true for 1937. During the year no new or revolutionary material or equipment was put on the market and no material or equipment in use during the past few years was discarded. In general, progress was made by increasing the efficiency and reliability of equipment, by bringing closer to perfection various processes and methods of treatment, by intensive research work along many and varied lines, and by bringing about better coordination of the work of the various governmental organizations in the waterworks field.

The droughts and the floods of the past few years have brought about a rude awakening as to the importance of an adequate and an unfailing water supply, and this has led to long-time planning and a willingness to expend large sums of money in going great distances for a reliable source of supply. The projects being carried out by Los Angeles, San Francisco, Denver, and New York illustrate this tendency. Due to local conditions in the west and southwest there is an urgent demand for larger storage facilities. It should also be noted that there has been an increasing interest by state and national governments in the elimination of sources of water pollution, and state authorities are assuming control over water resources in order to conserve the supply and to allocate it in an equitable manner.

Development in purification

A cursory examination of the records indicates that 88 new water treatment plants were completed in 1937, and additions or alterations were made to 33 existing plants of varied type and size.

Probably the chief development in water purification, brought about within the past decade, has been in methods for the elimination of taste and odor. Ammonia is used to prevent chlorinous tastes, and activated carbon is used to remove tastes and odors present in the water. More refined methods of testing odor in water have been developed, and this aids greatly in the application of corrective treatment. The use of ferric chloride and chlorinated ferrous sulfate has been extended slightly. Such substances as bleaching clay and bentonite have been tried in a few plants, with indications that there may be a limited field for their use. Methods of removing fluoride from water at a cost within the bounds of what may be expended for such purposes are nearing perfection.

Silica naturally present in water has been found to have considerable influence on the coagulation of water. Also it has been found that the addition of acid-treated sodium silicate to water greatly improves the coagulation with aluminum sulfate and ferrous sulfate. While this development has not been fully explored at the present time, there are indications that it will offer aid well worth its cost in the treatment of a number of waters.

Chief developments in filtration plant structures are mechanical flocculators for mixing basins and surface washing systems for filter beds. A procedure for testing the cleanliness of filter beds has been devised, enabling the effectiveness of washing systems to be compared. Porous plate filter bottoms to avoid the use of gravel are being tested in several filtration plants. Anthracite coal for the filtering material also is being tried in a few plants. There is a growing tendency to use coarser sand with lower uniformity coefficient in filter beds, and increasing interest is being shown in subsurface filtration; the general opinion seems to be that the latter scheme has possibilities for the future. During the past year there were a number of installations of small filtration plants of a type which recirculates the precipitated slurry into the incoming water. The circular prefabricated steel type of filtration plant has been installed in a number of cities.

Chlorine continues to be the principal sterilizing agent used in connection with water supplies, although in many instances ammonia is being used in conjunction with the chlorine. There is a tendency to go to automatic control especially

Table I—Comparison of Efficiencies of Steam Turbine-Driven Centrifugal Pumps

STATION	Number of Units	Date of Erection	Capacity m. g. d.	Duty Million Ft. Lbs. per 1,000 Lb. Steam	Efficiency %		Rankine Cycle Ratio Percent
					Thermal (Overall)	Pump	
Central Pk	1	1922	60	164.4	16.23	83	51.8
Central Pk	1	1926	60	175.3	17.86	86	56.2
Western Ave	4	1927	75	208.4	21.1	86	60.6
Mayfair	2	1932	60	197.6	20.9	90	66.0
Central Pk	1	1937	80	212.4	22.5	90	70.4

Table II—Comparison of Efficiencies of Electric-Motor Driven Centrifugal Pumps

STATION	Number of Units	Date of Erection	Capacity m. g. d.	Efficiency %			Type of Motor
				Motor	Pump	Overall	
22nd St	2	1912	20	94	69.8	65.6	Synchronous
22nd St	2	1919	30	92	77.2	71	Induction
Chicago Ave	4	1920-21	40	94.0	80.8	76	Induction
T. Jefferson	4	1928	40	94.5	87.2	82.4	Induction
Cermak	6	1935	50	97.9	91.5	89.5	Synchronous

where the chlorine demand varies considerably. The larger pumping stations are now using chlorine in ton containers, and master chlorinators have been developed of capacities up to 2000 lb. of chlorine per 24 hr.

Cast iron continues to be the predominant material used for conveying water in distribution systems. Manufacturers have increased the unit tensile strength of pit-cast iron to over 22,000 lb. per sq. in., and are producing a more flexible pipe. Centrifugally cast pipe is now produced from 4 to 30 in. in diameter and in lengths up to 20 ft. There has been an increase in the use of steel pipe generally throughout the country and asbestos-cement pipe is being manufactured in increasingly larger quantities for use in soil unsuited for either cast iron or steel. The past year has seen an increasing use of elevated storage tanks, to provide storage to take care of peak loads and to maintain uniform pressures throughout a system.

A word on operation

During the past year there were comparatively few installations of large pumps, but wherever large pumps were installed they were of the centrifugal type, the old reciprocating pump being given no consideration. In order to show the remarkable improvement in the efficiencies of centrifugal pumps, steam turbines, and motors, I would call attention to the tabulations (Table I and II) which give certain data concerning pumps installed in the Chicago water supply system from 1912 to date. The Rankine cycle ratio indicates the increase in the efficiencies of the steam equipment, and the overall efficiency of pump and motor shows the increase in the electrically-operated equipment.

It is to be noted that in many parts of the country operating costs are being greatly reduced by cleaning mains and lining them with cement in order to bring back their original carrying capacity, and by replacing obsolete equipment by modern and efficient machinery.

In our large cities the installation of air conditioning equipment continues to present the most complicated and difficult problem now facing waterworks officials. In some cases such installations tax the capacity of the water supply system, and in other cases they overload the sewers. Some large installations that have been proposed are being held in abeyance in the hope that some future development will make available a more economic solution of the problem than is now possible.

Summing up, a review of the history of the waterworks field during 1937 indicates that all those concerned, officials, operators, and manufacturers, have been very much alive to their duties and responsibilities and have continued to make an enviable record.

Hydraulic Knowledge

by J. C. Stevens

Consulting Engineer (Stevens & Koon), Portland, Ore.

Better theory is evolving in hydrology and hydraulics, and gains are realized in model study

Knowledge of hydraulics has been of slow and ofttimes painful evolution, as is true of other sciences, and its progress is best marked by monuments representing definite strides of advancement. Within recent years, stimulated by the solution in rapid succession of a number of baffling problems regarding fluid motion in the field of aeronautics, we should have had to place these monuments rather close together.

We could well erect monuments to L. Prandtl and T. von Karman for bringing to hydraulics an understanding of the energy loss in turbulence, which is having far-reaching effects, radically modifying our conceptions of many hydraulic phenomena that we had thought were pretty well crystallized but now suddenly find to be in a state of violent flux.

One hears so much today about fluid mechanics of air foils, boundary layers, and the dimensionless parameters, such as Reynold's Number, Froude's Number, Weber's Number, that some of us "oldsters" are tempted to go back to the classroom and laboratory and catch up. The science of hydraulics has bowed to the god of empiricism so long that it now finds itself handicapped by the very rites that stimulated its growth, and is almost reluctant to accept the new dispensation.

Take, for instance, this creature of roughness, never understood, of course, but pretty well tamed by a few standard empirical formulas. Now it has gotten entirely out of hand, jumped the fence into the Elysian fields of research, and hardly deigns to recognize its old masters. A unit of roughness has been established. Erect monuments to J. Nikuradse, L. Hopf, K. Fromm, and L. Schiller.

And let us not fail to erect a monument to the memory of John R. Freeman, whose endowed scholarships and other philanthropies have brought to us Americans the result of years of methodical research from European countries that otherwise might well have "wasted its fragrance on the desert air."

Hydraulic models

The hydraulic model has but recently become an indispensable tool linking theory and practice. Through research by means of models, single-stage pumps are now being constructed for the Metropolitan Water District of Southern California for discharges up to 200 cu.ft. per sec. under heads to 440 ft., with efficiencies as high as 92 per cent. And the end is not yet. The Bureau of Reclamation is now sponsoring a continuing program of research by means of models at the California Institute of Technology for single-stage pumps for the Grand Coulee project that will deliver 1,600 cu. ft. per sec. under heads of nearly 300 ft.

Throughout the world an astonishing amount of hydraulic research is

under way, for the most part by models. New laboratories are being erected, new techniques are being developed, the inherent limitations of models are being recognized, perhaps at some loss of prestige, but all looking toward knowledge of greater accuracy and value concerning basic principles in this highly specialized field.

The Special Committee on Hydraulic Research of the American Society of Civil Engineers is sponsoring research into problems of pure hydro-physics, to coin a term. How does water flow around a bend; how does it flow through an expansion, exchanging its kinetic for potential energy; what happens when two streams intersect; how do waves form on steep slopes; what sedimentation occurs when two silt-laden rivers join forces? We are curious about what is going on inside the water body and at its boundary layers, what turbulences are set up, how and why it does as it does. Let us erect a monument to the Engineering Foundation, which is making such studies possible.

River studies

The Waterways Experiment Station at Vicksburg, Mississippi, has been a most potent institution for the U. S. Engineer Department in the solution of one of the major engineering problems of the age, the control of "Old Man River." Years ago the solution was thought to lie in maintaining his status quo, in preserving every capricious bend with levees and armored banks. Every curve was sacred; nature made them and nature knows best. Today Mother Nature has been challenged to show cause why these capricious bends should not be eliminated by cut-offs.

Within the past five years a dozen cut-offs have been excavated between the mouth of the Arkansas and the Red River, shortening the river 112 miles in an original length of 370 river miles, an achievement of moment on a navigable waterway. Relief basins and spillways have also been developed. If the unprecedented flood of 1927 should recur, it would probably be carried through this reach of the river at a gradient many feet lower than the gradient of that year.

And what has emboldened us to make this challenge? Experimental work on hydraulic models. They have not only pointed the way but given us a substantial measure of confidence in the results. That faith in this program is not misplaced was well attested by the unprecedented flood on the Ohio River of 1937, that passed down the Mississippi without taxing the levees, relief basins and spillways.

Let us also erect a monument to Gen. Harley B. Ferguson.

Toe scour at dams

Reducing the scour below overflow dams to a minimum is another accomplishment for which model studies must be given their just measure of credit. Two prime factors have been largely responsible, (1) a new familiarity with and appreciation of the hydraulic jump, and (2) the development of effective types of baffles that, co-operating with the jump, have produced such decided improvements in the solution of this problem that we now look upon some early attempts at its solution with almost bored tolerance. Erect monuments to J. M. Belenger, Karl R. Kennison, Theodor Rehbock, Sherman Woodward, Boris Bakhmeteff.

On the Madden Dam, where the water falls 120 ft., small piers supporting Pitot tubes were erected on the concrete face in the path of the overfalling water. While models showed the velocities to be within 90% of that due to the head, field tests showed them to be far below that limit. The answer is found in resistances produced by air. When velocities exceed about 10 ft. per sec. the water begins to entrain air, until at very high velocities the mass has become a flowing "tub of suds." From this it appears as if such velocities might have an upper limit of about 80 ft. per sec. Erect a monument to Armin Schoklitsch.

Grand Coulee Dam promises to be the most spectacular achievement in applied hydraulics and structural technique of the generation. On its face, small streamline piers, each supporting a battery of Pitot tubes, are being placed by which the velocities of water flowing down its concrete face under heads of 280 ft. will be definitely determined. Erect a monument to J. L. Savage.

Hydrology

In this field, perhaps the idea of predicting spring run-off on mountain streams by systematic snow surveys on their headwaters should be given the place of honor. They have already become an indispensable aid to operation and will become increasingly important as more reservoirs are placed in operation. Nine million acre-feet of capacity are reserved in Lake Mead for flood control. The floods on Colorado River that need concern this mammoth reservoir most are those from spring snow melting. Predicting spring run-

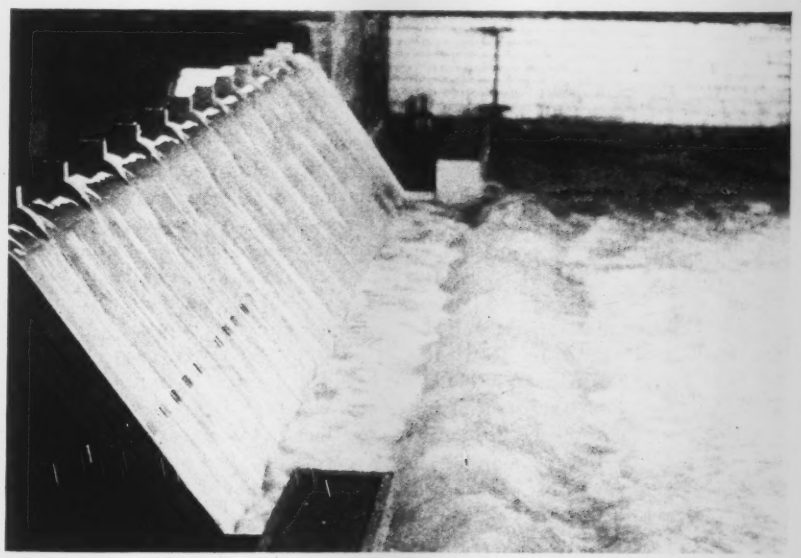


Fig. 1. Model of Grand Coulee Dam constructed on a scale of 1:120 in the U.S. Bureau of Reclamation laboratory at Fort Collins, Colo.

off will multiply the usefulness of that reservoir many times. And so it is with the thousands of other reservoirs existent and prospective thoughout the west and east. Curiously enough the pioneer in snow survey work was not an engineer, not even a meteorologist, but a professor of romance languages. Erect a monument to Dr. J. E. Church.

Survey of Sewage Treatment

by George B. Gascoigne

George B. Gascoigne & Associates, Consulting Engineer, Cleveland and New York

Practical accomplishments in research and the construction of many treatment plants marked 1937 advances

Stocktaking at the beginning of a new year is traditional. Such a periodic review of sewage treatment is particularly desirable as a means of orientation in a scene that is changing rapidly—not so much in fundamentals but in the methods of application.

The loss of such early leaders as O'Shaughnessy in England and Eddy and Gregory in this country serves to emphasize the changing picture and to stress the fact that another generation is seeking to express itself by building upon the firm foundation established by the elders of the profession.

It is a fact also that the favor for sewage treatment methods is swinging erratically—now to chemical treatment, now to mechanization, now to incineration, ever hopeful of reaching some millennium of disposal methods.

During the past year one significant development which has become marked is the increased public concern in pollution matters. Probably the most notable example is the plan of control for the Ohio River Valley, which establishes new principles in the federal correlation of state sanitation and in financing. Likewise significant are the steps taken by the Indiana Department of Health to clean up waters tributary to Lake Michigan, involving substantial industrial-waste treatment. Also, the more drastic pollution statutes in Pennsylvania cannot be overlooked.

Movements of this character have not been unusual in the remedy of local pollution, but the scope of recent legislation (which may reflect the stimulation of planning) points to a general expansion of governmental control—possibly to the extent of taking over, generalizing and making authoritative functions that have been exercised by sanitary engineers in behalf of municipalities and similar single agencies for particular cases.

Diversity in research

Progress in sewage treatment is shown in one aspect by reference to current research. In this field there has been a widespread and a greater diversification of investigation on a scale beyond laboratory scope. Thus, the technical journals have carried data relating to higher rates on trickling filters; centrifuging of sludge for relatively complete dewatering or for partial moisture reduction; grinding of garbage for over-all treatment with sewage sludge; elutriation of digested sludge; precipitation with a variety of chemicals, and digestion of sludge to shorten the period or increase the gas yield. All of these represent undertakings that may have effect upon the design and operation of treatment works, and should be watched accordingly in planning new work.

While there has been some renewal of interest in byproduct recovery, the prevailing view is that the treatment of sewage is essentially a problem in disposal and that any salvaging should be but incidental to fundamental processes. However, the recovery of sewage gas for its fuel and power value is becoming very general, and increasing development and use of this byproduct may be expected.

A corollary to research is the wide publication of results. Investigators have been very free in making available the results of their work, and the distribution of detailed and specialized data has been furthered by the numerous and growing sewage works associations, and particularly the Federation of Sewage Works Associations, now completing its tenth year of useful existence.

Current developments

During the past year a greater number of large sewage works have been placed in operation than in any other preceding year. A considerable number of interesting small plants have also been built as a result of federal financing. In this connection mention should be made of the new plant at Jackson, Mich., which is probably the first installation to make use of tapered aeration.

Insofar as the newer plants portray progress or change from the practice of the past, it is apparent that considerable emphasis is being given to incineration as a means of disposing of sludge. It is a little surprising to find this trend manifest in a number of moderate-sized plants as well as in the larger installations at Chicago, Buffalo and Cleveland.

Another phase of sewage treatment that stands out is the resort to chemical precipitation, notably at Coney Island, N. Y., at Minneapolis, and at Denver, where this mode of treatment has been adjudged the answer to the need for seasonal increase in purification results.

Oxidation treatment appears in different attempts to speed up filtration on trickling filters. At the Camarillo, Calif., plant the process is featured by recirculation of the filtrate with previously settled but unfiltered sewage. At Cleveland, on the other hand, an abbreviated period of activated sludge treatment with tapered aeration is relied upon to reduce the organic load prior to filtration, and so to enable increase of liquid load on the trickling filters. At Atlanta, chemical treatment is being used to reduce the organic loadings.

The older processes show little change structurally but there is a trend to higher rates and more complete use of capacity. Control of the

mechanized elements of processes is becoming more intricate in the quest for interlocks and automatic operation, while mechanical equipment itself is being perfected. Chlorinators are appearing in capacities up to 5,000 lb. per day per unit, while at Niagara Falls, following the earlier installation at Norwalk, Conn., fine screens for essential treatment are being provided with coal mats for added purification.

Factors influencing progress

Any attempt to appraise the position and possible future trend of sewage treatment from the evidences of development that have been indicated must recognize what might be termed the business aspect. Owing in large part to federal aid, the recent years have been marked by unusual activity in the construction of treatment works. The need for such improvements is still strong, but the stimulation of construction has eliminated many marginal projects that otherwise would now be prospects.

These conditions signify that many unavoidable enlargements of overloaded plants will be of the nature of patchwork, and that the struggle for funds will sacrifice needs to expediency. To balance this, it may be that some of the larger cities will find it opportune to utilize the interim period of slack construction for still further investigation and experiment.

Another direct element in any estimate of the future is the question of simplification of treatment processes. In the 1900's the treatment of sewage was by processes that can be described as compact and inclusive. Of late we have been multiplying the steps in the over-all process, with consequent increase of structures and equipment, each segregated to subdivisions of principal functions. In other words, stages of treatment that were at most but incidental have been magnified to major importance. This development resulted from demands for saving labor, for reduction of nuisances, for greater effectiveness in basic treatment processes, and for economy. In view of such varied needs, it may be expected that the large works will continue to subdivide the overall process to a considerable extent, but it also appears that the small plants and those with moderate purification requirements will show consolidation to the end of obtaining greater simplification and a lessened need for the higher skills in operating.

Appraising future trends

From the several viewpoints expressed herein, the following statements seem to be a fair evaluation of the year as to future trends:

There will be a clearer delineation of the applicability of various processes of treatment to different requirements for purification. In this, oxidation methods will receive greater emphasis and chemical treatment will be approached more rationally. It seems probable that in all but the larger plants there will be recognition of the need for digesting sludge.

Greater attention will be given to contriving one or more of the plant structures to function as cushion or balancing devices in the line of processing. This will be true even in the more flexible designs that have characterized recent plants. The objective will be to equalize loadings (that is, storm flows), and to furnish protection for operating lapses.

Mechanical equipment will be improved or even redesigned to conform better to sewage disposal plant conditions instead of being adapted from other fields of usage. Progress in this will be manifest particularly in equipment for the handling and disposal of end products.

Floods and Flood Control

by THEODORE T. KNAPPEN

Consulting Engineer (Parsons, Klapp, Brinckerhoff & Douglas), New York

Year marked by great Ohio River flood and first test of Mississippi control system saw much progress in studies and construction

JANUARY of 1937 produced in the Ohio basin the most disastrous flood in the history of the United States. More than half a million people, most of them confident of their security from floods, were driven from their homes. Direct damage in excess of $400,000,000 in this flood was estimated by the Chief of Engineers, U. S. Army. Major damage centers were Wheeling, Huntington, Portsmouth, Cincinnati, Louisville, Evansville, and Paducah.

Not until the floodwaters reached Cairo, at the mouth of the river, was the destruction checked. Cairo, by virtue of a hard fight and the operation of the New Madrid floodway, was saved from inundation. Likewise, Hickman and the Reelfoot Levee district of Kentucky and Tennessee had a close call. South of New Madrid, record stages continued to the mouth of the Arkansas, but the 1928 levee grades and sections proved ample to meet the situation. From the mouth of the Arkansas to the mouth of the Red, stages were materially below the stages reached in the smaller flood of 1929, due to the program of channel improvement by cutoffs that had been carried out in this reach. Because of this, and because the White and the Arkansas were not in flood, the levee at the head of the proposed west bank floodway was not overtopped. From the mouth of the Red the flood was successfully carried in the main river and the Atchafalaya.

No other serious flood developed during the year until the Sacramento went on a rampage in December. While the damage was material, the main flood-control system functioned smoothly to prevent a serious situation.

Plans for protection

The Ohio flood of January was of a magnitude that few engineers had dared to predict. To protect against its recurrence is proving to be a gigantic task. The Chief of Engineers, U. S. Army, in his report to

Fig. 1. Part of Louisville, Ky., during the Ohio River flood of January 1937.

Congress dated April 6, 1937, estimated that the total cost of protective works would approach $500,000,000, about half of which is for reservoirs additional to those authorized in the 1936 flood control act (at estimated cost of $85,000,000), while $230,000,000 is for local protection works. It may be anticipated that further studies will be made before any of the works are finally adopted. In view of the fact that reduction in stage by reason of this system, below Cincinnati, is less than 3 ft., the justification for the reservoir system needs careful analysis.

Mississippi and East

The planning of the Mississippi flood control project is a hydraulic problem of considerable intricacy. When one considers the varying magnitude of flow and the nature of the channel and the overbank areas, it is not surprising that actual flow lines depart materially from those projected. A source of real gratification was the success with which the system from Cairo to the Gulf went through its first major test. At Cairo, however, with a flow of about 2,000,000 sec.-ft., the stage was approximately equal to the stage predicted for a 15 per cent greater discharge. Apparently a program of levee raising from Cairo to New Madrid, supplemented by channel improvement and a cutoff at Slough Landing Neck, is necessary to pass a flow 25 per cent greater than in 1937. At other points also some levee raising will be necessary.

In New England, the states concerned in the protection work on the Connecticut and Merrimack rivers drafted and ratified interstate compacts for flood control purposes in accordance with the flood control act of 1936. These compacts contained provisions, retaining for the states the power rights at the various reservoirs. This clause in the compacts was questioned by the national administration, and as a result Congress failed to ratify them during the first session. Meanwhile local protection work for Haverhill, Lowell, Fitchburg, Springfield, Hartford, and some smaller communities along the two rivers involved has proceeded with relief funds.

On the Susquehanna local protection works have been initiated at Hornell, Binghamton, Wilkes-Barre, and other places, and reservoir plans are advancing towards early construction. Construction is nearing completion on the Waterbury dam, the last unit of the Winooski plan in Vermont. The only other important projects on the Atlantic seaboard are at Augusta and Rome, Ga., where work will start shortly.

The reservoir project for the protection of Pittsburgh and the upper Ohio has progressed well into the planning stage, and bids were received in December on the two large earth dams for the Crooked Creek and Tionesta reservoirs. The Muskingum project is nearly completed.

Work is getting under way on the Upper Mississippi projects and it is anticipated that over $2,000,000 will be expended next year. The Yazoo project was initiated with the start of construction on Sardis Dam. Plans are about ready for the protection of the low areas at Memphis.

On the Arkansas River Conchas Dam is nearing completion, and Fort Supply Dam will be started at an early date. Miscellaneous local protection projects totaling $3,500,000 are getting under way. On the Pacific coast, work is proceeding on the Los Angeles County and Santa Ana River projects, with about $12,000,000 allotted for the fiscal year. The Central Valley Project promises additional flood protection in the

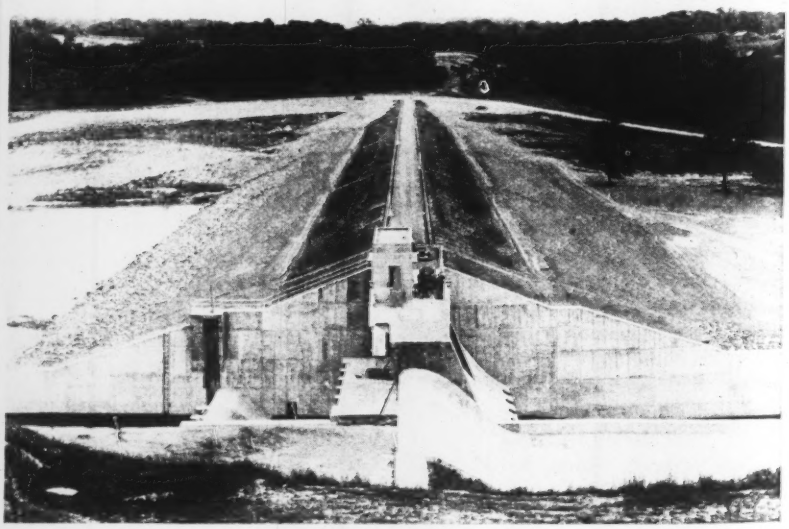


Fig. 2. Charles Mill Dam of the Muskingum flood-control project.

Sacramento Valley. Minor projects are under way on the Columbia and Willamette rivers.

An act of Congress authorizing complete flood-control investigations was vetoed by the President. There still remains a basic necessity for thorough study and analysis of the engineering and economic problems in connection with flood-protection projects. Many projects lacking in economic justification have been carried through as relief projects, and many others have been authorized by Congress without adequate engineering and economic studies. There is a real need for a searching analysis of our flood control policy.

In general, Congress established the policy in the Flood Control Act of 1936, that a project was justified when the aggregate benefits exceeded the cost. The technic for determining average annual benefits by the loss probability method has developed rapidly and now is in quite general use, but there still is wide divergence of opinion as to what items should be included in benefits.

One outcome of the economic studies is the need for zoning of flood areas, with restriction of use to purposes not seriously affected by flood. Many of our cities would do well to have this problem studied in order to control unwise development. In a few instances, as at Shawneetown, Ill., towns are planning to move bodily from flood zones.

In the field of design, there have been marked improvements. More attention is given to accurate flood routing, and the location and size of reservoirs are studied with a view to obtaining the most favorable benefit-cost ratio.

In the design of flood-control structures empirical methods are slowly yielding to rational analysis. Various types of earth and rock dams are used in increasing number, permitting wider selection of economic reservoir developments. Likewise in the design of walls and levees the developments of soil mechanics are providing solutions for the problems of subsidence and seepage, which have appeared to limit the permissible heights of these structures in the past. The difficulties which once appeared insurmountable in the protection of such places as Cairo, by levee raising, are no longer obstacles to the planning engineer.

Developments in Soil Knowledge

by GLENNON GILBOY

Associate Professor of Soil Mechanics,
Massachusetts Institute of Technology, Cambridge

Knowledge of settlement, earth-dam design, compaction of embankments and yielding of dam foundations was advanced during the year.

IN this summary of developments in soil mechanics during the past year, and of their application to construction problems the writer includes only those projects with which he is familiar through personal participation or through direct contact with colleagues. Omission of other contributions should not be construed as a reflection upon their value.

An event of interest was the first meeting of the new Soil Mechanics and Foundation Division of the American Society of Civil Engineers, in Boston. Papers were presented by Prof. Arthur Casagrande, B. K. Hough, Jr., S. J. Buchanan, and the writer. All but the first are now available. See footnotes[1,2,3].

Settlement observations

Professor Casagrande's paper described a noteworthy attempt to verify laboratory predictions by careful measurements of settlement. Before construction of a large building in Boston, complete settlement analyses were made. Settlement data were recorded from the beginning, and the observations are to be continued over a period of years. As complicated subsoil conditions required simplifying assumptions in the analyses, and as these were always on the conservative side, the measured settlements have been less than the predicted; nevertheless, the magnitude and pattern of the settlements follow predictions.

As a corollary, Prof. P. C. Rutledge made a study of the relations between the plasticity characteristics of clay and its compressibility in the undisturbed state. The Atterberg limits have been used for years to aid in the preliminary grouping of soil samples, but direct relationships with compressibility have not been fully investigated. Prof. Rutledge found certain correlations which, if they can be generalized, should be of material assistance in testing.

The subject of borings also received attention. A general discussion was led by H. A. Mohr, whose recent paper on this topic is a contribution of outstanding merit.[4] "Undisturbed" sampling is still far from perfect, although improvements are steadily being made.

A thorough study of the stability of slopes was completed last summer by D. W. Taylor.[5] Of particular value is the analysis of the effect of rapid lowering of the water level against the face of a saturated slope. It has long been known that this is a dangerous condition; that slopes otherwise stable may slough when subjected to sudden drawdown, with resultant introduction of seepage forces toward the face.

Prof. Casagrande, discussing seepage through dams,[6] dealt fully with the use of the flow net and proposed graphical solutions for various boundary conditions.

Jamaicaway fill subsidence

An interesting foundation problem was presented by the subsidence of an approach fill to a new overpass on the Jamaicaway in Boston. Borings disclosed an underlying tongue of silty peat, the presence of which had not been suspected because an existing fill, carrying a heavily traveled highway, bridle paths, large trees, and so on, had stood without mishap for many years. The new fill load, not particularly heavy, was just enough to cause a shear failure in the underground.

Undisturbed samples were re-

moved and tested. The first step in the studies made by Mr. Taylor and the writer was an analysis of the equilibrium conditions of the fill which had subsided, in order to be sure that the general method of attack was sound. A satisfactory correlation was obtained, and studies were then made of various revised designs. It was found that to obtain a proper factor of safety the fill slopes would have to be so flat as to interfere seriously with landscaping and drainage of an adjoining pond. The solution finally adopted was to carry the roadway on steel bearing piles driven through the peat to firm bearing below, and to lighten the trimming slopes as much as possible.

Another aspect of the settlement problem was studied by the writer in connection with the proposed second navigation lock on the Mississippi River at Hastings, Minn. The existing lock, resting on sand underlain by clay, has undergone some gradual settlement since construction. Analyses based on tests made at the Vicksburg Experiment Station checked the measured settlements closely. Hence it is expected that the predicted settlements of the proposed lock, computed on the same basis, will be reasonably accurate. In order to minimize the settlements, the writer recommended a lightening of the backfill load, and also the omission of the traditional bearing piles, using instead a double wall of steel sheet-piling to confine the sand stratum beneath the lock.

Fig. 1. Jamaicaway approach fill subsided through crushing of peat layer in subsoil and was replaced by piled roadway.

Fig. 2. Compaction tests of sand for a Merrimack River flood-control dam showed tractor and sheepsfoot roller to produce maximum density.

Design of earth dams

Various Army Engineer districts have been contributing to the development of earth dam design. Last summer Major G. J. Nold, district engineer, and A. C. Bruce, chief engineer, of the Binghamton engineer district, expressed the opinion that the design of rolled-fill dams includes too much guesswork, and that some attempt should be made to work out a more rational approach. The common type of problem, involving an impervious cohesive core surrounded by a pervious cohesionless shell, is a rather complicated one, on account of the wide difference in character of the component parts. The writer proposed a method based on a combination of Taylor's analysis of cohesive slopes subject to water forces and the writer's analysis of the stability of hydraulic-fill shells subject to bursting forces.[5,7,8] Extensive studies of the method have been made by the staff of the district laboratory at Ithaca, under the direction of Mr. Hough.

The basic idea is simple. The maximum restraining force which the shell can exert can be found from the writer's equations, and a study of the stability of the core will then show whether this force is sufficient to maintain equilibrium.

Compacting a sand dam

In the Boston district, in connection with a proposed flood-control dam on a tributary of the Merrimack, question arose as to whether the material available for borrow could be compacted satisfactorily. Large-scale tests were made on embankments up to 12 ft. in height with various methods of compaction. Excellent compaction could be obtained with a heavy caterpillar tractor pulling a disk or sheepsfoot roller. The most interesting feature was that almost all the compacting effect was due to the tractor, the roller contributing a comparatively small amount; the kneading effect and tractor vibration do the work.

Collaborating in this investigation, Prof. Casagrande has made further studies of the stability of cohesionless materials.[9] It now appears that

between the loose, unstable state and the compact, stable state there exists not a line of demarcation but a rather wide range of uncertain behavior. To insure permanent stability, compaction should always be carried well below this range.

Dams on yielding foundation

The design of embankments on yielding foundations, upon which some preliminary ideas have been advanced by Dr. Jürgenson and the writer, is still under investigation.[10, 11, 12] Foundation displacements in certain of the Muskingum dams have convinced the writer that unmodified application of Jürgenson's solutions, for vertical loads only, is not a sufficient criterion of stability. Horizontal reactions are equally important, and must be included. That such forces exist, and are of considerable magnitude, appears evident if a symmetrical dam is imagined to be split at the center line and one half is considered to be removed. To keep the remaining half in position, some restraint would be necessary, such as a bulkhead braced externally in some fashion. Without question, the bracing would have to carry heavy horizontal loads, and the aggregate of these loads would have to be balanced by an equal and opposite shearing reaction on the plane at the base of the dam. Furthermore, the total force would tend to increase with the square of the height, while the base area, assuming constant slopes, will go up with the first power. Hence the average intensity of shearing stress will increase directly with the height of the dam. If the foundation consolidates as rapidly as the load is applied, everything will be balanced, because the shearing strength will also increase with the height. On the other hand, if consolidation is slow, the shearing strength may not develop as rapidly as needed. Therefore, in fine silts and clays the problem becomes one of great practical importance.

It is interesting to note in this connection that the traditional concept of stable slopes in dry sand—i.e., that an embankment of sand will be stable at any height if the slopes are flatter than the angle of repose—is not correct if the underlying material does not possess the proper characteristics. If a sand embankment is piled at a constant slope on a soft clay foundation, sooner or later a height will be reached at which the clay will move out and cause embankment failure.

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Civil Engineering Research

by S. C. Hollister

Dean, College of Engineering, Cornell University, Ithaca, N. Y.

Extension of knowledge in soils, hydraulics and structures paralleled by development of practice

Since in any calendar year one can do no more than block off a certain portion of the ever flowing development in engineering, one may fairly consider as belonging to any one year those things which, during the year, have become significant. No progress can be assigned to any one year that does not have its roots deep in the years preceding.

Soils and hydraulics active

During the year the greatest interest in basic research appeared to be in the field of soil mechanics. Activity in this field has been stimulated because of the broad application of the principles involved. The constructor of earth dams and other earth works, the foundation engineer, designer of building and other structures, the highway engineer, and the railway engineer are all deeply interested in soil science development as a basic factor in their work.

Application of laboratory procedures to field control has greatly advanced in all construction having to do with soils. Stabilization of soil by various means has also received attention. Removal or testing of undisturbed samples of soil at considerable depth is difficult and is due for further development. Analysis of stresses in earth constructions is receiving considerable attention and will likewise be a fertile field for future advancement.

Study of the flow of fluids through porous media has notably advanced during the year. Research in open-channel flow and in the behavior of structures involved in low-head hydraulic works has also been active. In this field the use of models has been so extensive as to take on the aspect of a standard procedure for the study of the behavior of special constructions; it appears destined to have a large future.

Coupled with the activity in hydraulic research is the continued development during the year of the application of fluid mechanics. While the work of the hydraulic engineer will continue to be empirical in certain respects, the development of fluid mechanics is bound to have important influence through the application of an analytical approach to hydraulic problems. Through such

advancement also, the use of convenient analogies will advance under intelligent control.

Structure development

Notable contributions have been made during the year through further application of advanced analytical methods to stress problems. The use of such methods is certain to continue with increasing benefit. Photoelastic analysis and determination of stress by the use of models continues to find wider use.

Research continues in a wide variety of problems relating to welding. Fatigue tests of full-size structural welded joints are in progress. Load tests of structural connections applicable to continuous frames have been made during the year.

In the field of structural engineering notable achievements have culminated during the year, the greatest of which are the opening of the San Francisco Bay and the Golden Gate Bridges. Important developments have also taken place in the extension of the use of alloy steels for structural purposes.

During the year a progress report was issued by the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. The significant feature of this report from the structural engineer's viewpoint is the adoption of computations of stresses in frames on the basis of analysis of the frame as a whole, rather than on the basis of analysis of individual members. This marks a distinct advance in design and is bound in time to be extended to structures built of other materials.

Development in the concrete field continues active as in the past. Problems relating to use of concrete in large masses continue to be under study with notable results. Considerable attention is being given to the introduction of varying amounts of puzzolanic cements, both in mass structures and in concrete for highway slabs.

Municipal problems

Activity in municipal engineering centers upon sanitation and upon traffic problems. Sewage treatment is receiving continued study, not only from biological aspects but also with regard to the treatment of industrial wastes. These latter wastes in some instances affect waterfront structures and also fish and shell life. In certain areas their presence has assumed critical proportions.

The increased vehicular traffic in metropolitan areas has placed a growing burden upon these governmental units. The Riverside Drive development in New York and the Outer Drive development in Chicago have been notable advancements during the year, in the effort to segregate through traffic. The San Francisco bridges and the Lincoln Tunnel, all completed during the past year, are further steps toward the solution of traffic problems in metropolitan areas.

Great activity in regional planning and broader planning of public works throughout the country are symptoms of current constructive thinking. Proposals now before Congress undertake to organize such planning as it relates to our water resources. The planning of flood control has been carried forward during the year on a national basis, but the extent to which such planning will be done by the states or by the federal government is a problem for immediate attention.

Development of parks, better disposition of land use, and the relation of land to water resources are receiving increasing attention. Engineers can and should extend their service to the community by cooperating in the solution of these basic economic and social problems. Perhaps at no time in the past has the recognition of economic and social consequences of engineering works by the public at large been so clear. It is a challenge to the profession, which may have important bearing on the future position of the engineering profession in the social structure.

Railway and road

Research in railway engineering continues active, led by the two great continuing researches — stresses in railroad track and the rail fissure investigation. The track investigation has been concerned with the effect of high-speed heavy equipment, while the rail investigation is continuing with further explorations into causes and control of shatter cracks.

During the year further developments have taken place in railway operation in the direction of higher speeds and light equipment in both passenger and freight transportation. In the east the Pennsylvania R.R. is engaged with the extension of its electrification, while the Reading has installed a high-speed light-weight passenger train on its Philadelphia-New York run. Several roads in the west have extended the use of both steam and diesel powered light-weight passenger trains. The pullman equipment is being developed in parallel with other passenger equipment. The popularizing effect of the new high-speed trains is notable and presages marked advances in this direction.

The development of design and construction methods which have resulted in the achievement of the light-weight, high-speed trains has been a notable advance, both in the use of materials and in methods of fabrication. It seems reasonable to expect this development to extend into other fields than railroading.

In the road field, besides considerable development in subgrade and soil stabilization, distinct progress is being made in highway planning. Parkways and freeways have been further developed during the year and the separation of opposing traffic is also receiving close attention. Research is active in highway subjects, from materials to design and service.

The greatest problem now facing the highway engineer is the reduction of highway accidents. The "budget" for highway accidents for 1938, conservatively based upon past trends, provides for as many killed and nearly four times as many wounded as suffered by the American forces in the entire World War. Such an appalling casualty rate would appear to call for a national action fully as vigorous as the combined actions of societies for peace and for the prevention of the more devastating diseases. Engineers in all branches of the profession could well devote their best efforts to devices and other means for the prevention of accidents. The engineer has succeeded in remarkable reductions in accidents in railway transportation; the combined efforts of all branches of the engineering profession should be able to effect great reduction in our continuing toll of avoidable highway accidents.